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NEW OR POORLY UNDERSTOOD TERTIARY SEPIIDS FROM SOUTHEASTERN UNITED STATES AND MEXICO

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ABSTRACT

A detailed reinvestigation of the holotypes (and only known representatives) of *Belemnosella americana* and *B. floweri* has confirmed the specific independence of these two species from the upper Claiborne Group (middle Eocene) of Alabama and Mississippi. The morphology of a solitary specimen of *Belemnosella* from beds of the Claiborne Group at an unknown locality in Alabama is found to be so unlike that of either *B. americana* or *B. floweri* that this specimen is believed to represent yet another species of the genus. This specimen is provisionally designated as *B.* n. sp., JELETZKY, aff. *B. floweri* owing to the fragmentary nature and stratigraphical uncertainty.

A detailed study of this material has necessitated an emendation of the previously proposed diagnosis (JELETZKY, 1966) and phylogenetical relationships of this rare, apparently isolated geographically, morphologically peculiar sepiid genus. *Belemnosella* now appears to be a specialized and evolutionarily advanced lineage rather than a little-changed offshoot, of the hypothetical root-stock of the Tertiary sepiids. It appears to be closely allied to *Belemnosis* EDWARDS (1849), other representatives of the Belemnoseidae WILTSHIRE (1869), and all better-known genera of Spirulidae, Spirulirostridae, Belopteridae, Belosepiidae, and Sepiidae, because of the apparent absence of the proostracum, presence of a medioventral depression of the sheath, and some other important morphological features.

Belemnoseidae appear to be directly ancestral to Spirulirostridae. The genus, *Spirulirostrina* CANAVARI (1892, *sensu* NAEF, 1922), appears to be too closely related to *Spirulirostra* and other genera of Spirulirostridae to be placed in a separate family. The Spirulirostrinidae NAEF (1921) is therefore suppressed.

Vasseuria MUNIER-CHALMAS (1880) differs from all better-known Tertiary sepiids in possessing a long spatulate proostracum and a thin, *Dentalium*-like guardlike sheath which is devoid of the medioventral depression and variously shaped lateral outgrowths. This genus is therefore interpreted as the most primitive Tertiary sepiid known and as the least-changed descendant of the hypothetical root-stock of the Tertiary sepiids.

The types of *Spirulirostra americana* BERRY (1922) are redescribed and assigned to a new, monotypic genus, *Amerirostra*. The genus differs from all other Spirulirostridae in the apical part of its phragmocone which forms a complete turn so that the protoconch almost touches the ventral wall of the conotheca. Furthermore, the ventral side of the *Amerirostra* sheath is ornamented by two bosslike mid-ventral calluses (=capitula). The smaller adoral callus occurs inside the medioventral depression and harbors the coiled part of the phragmocone, while the larger adapical callus occurs at the apical end of the

medioventral depression. Other, probably taxonomically important morphological distinctions of *Amerirostra* may be the anteriorly obtuse, featherlike shape of the dorsal shield and presence of a medioventral buttress separating the adoral part of the dorsal shield from that of the phragmocone.

Amerirostra appears to be a strongly specialized, independent phylogenetical branch of Spirulirostridae derived from some *Spirulirostrella-* or *Spirulirostridium*-like ancestors and only homeomorphic with the European and Australian Spirulirostridae forms in some of its morphologic features. *Amerirostra* appears to be restricted to Miocene rocks of the Western Hemisphere where no other representatives of Spirulirostridae are known to exist.

INTRODUCTION

In a recently published coleoid paper (JELETZKY, 1966), I have commented briefly on the morphology of *Spirulirostra americana* BERRY (1922), *Belemnosella americana* (MEYER & ALDRICH, 1886), and *B. floweri* (PALMER, 1937). At that time I was greatly handicapped in appraisal of *Spirulirostra americana* by the unavailability of its only figured, exceptionally complete specimen (BERRY, 1922, fig. 1-5). Shortly thereafter this specimen was located in collections of the Smithsonian Institution, Washington, USA, and made available for study through kind cooperation of Dr. FREDERICK COLLIER. It became obvious at once that *Spirulirostra americana* differs from all hitherto described European and Australian representatives of the genus in several important morphological features. These distinctions are judged to be ample for erection of a new genus to receive this peculiar representative of Spirulirostridae NAEF (1921).

The holotype of *Belemnosella floweri* (PALMER, 1937) was made available for study through the kind cooperation of Dr. KATHERINE VAN WINKLE PALMER, Director of the Paleontological Research Institution, Ithaca, New York. A specimen of a closely related but apparently specifically new form of *Belemnosella* was kindly loaned for study by Dr. HORACE G. RICHARDS, Chairman, Department of Geology, Academy of Natural Sciences of Philadelphia. The study of these two *Belemnosella* forms and a concurrent, more detailed study of the holotype of *B. americana* (MEYER & ALDRICH, 1886) has resulted in reappraisal of the morphology and taxonomic status of *B. floweri,* as well as of the morphology and the affinities of the genus *Belemnosella* NAEF (1921) and family Belemnoseidae WILTSHIRE (1869 *emend.* NAEF, 1921).

Family BELEMNOSEIDAE Wiltshire, 1869

[nom. correct. JELETZKY, herein (pro Belemnosidae WILTSHIRE, 1869; Belemnosidae NAEF, 1921, jun. syn. homonym)]
[=Belemnosisidae AVNIMELECH, 1958]

TYPE GENUS.—*Belemnosis* EDWARDS, 1849.

DIAGNOSIS.—Sepiida in which phragmocone is almost to quite straight, except for apicalmost part, latter invariably endogastrically incurved feebly, forming less than 0.25 of turn; phragmocone extended at least to adoral margin of sheath, its camerae subtransversely oriented and moderately high; short and thin guardlike sheath has low and ill-defined moundlike ventral callus situated at adapical end of medioventral depression; apical end of sheath either obtusely rounded or extended into thin, short spine; medioventral depression occupying adoral part of sheath subtriangularly shaped, becoming slitlike adapically; this slitlike part of depression extends over part or all of ventral callus and subdivides it into 2 symmetrical parts; medioventral depression flanked by more or less regularly rounded sublongitudinal bulges occupying ventrolateral quadrants of sheath; these bulges and deep, fissurelike, sublongitudinal furrows separating them from medioventral depression converge adapically until they merge completely within ventral callus on apical part of sheath.

OCCURRENCE.—Lower to upper Eocene, lower Oligocene; England, Belgium, northwestern France, southwestern USSR, southeastern United States.

Discussion

EMENDATION OF DIAGNOSIS.—The diagnosis of Belemnoseidae previously given by me (JELETZKY, 1966, p. 106) is somewhat expanded and amended in this paper in the light of subsequent research. My previous conclusion that the surface of the phragmocone (i.e., of the conotheca) is exposed

within the medioventral depression of Belemnoseidae has proved to be erroneous. As in all other Tertiary Sepiida possessing a medioventral depression, the conotheca within the depression of Belemnoseidae is invariably covered by a thin layer of the guardlike sheath. The inappropriate term "mid-oral gash" which I proposed (JELETZKY, 1966, p. 106) for this feature of the Belemnoseidae sheath now is replaced by "medioventral depression" of the sheath. Furthermore, my proposal (ibid.) to designate the endogastric curvature of the apicalmost part of the Belemnoseidae phragmocone as "moderate" does not seem appropriate. This term is better reserved for phragmocone curvature approaching or slightly exceeding one half of a whorl and the term "feeble" is used instead for lesser curvatures.

HISTORICAL REMARKS.—The family Belemnosidae was erected by WILTSHIRE (1869, p. 33) to receive the following genera of fossil coleoids: *Belemnosis* EDWARDS, 1849; *Beloptera* DESHAYES, 1830; *Helicerus* DANA, 1849; and *Spirulirostra* D'ORBIGNY, 1842.

NAEF (1921, p. 536) proposed the same family name for *Belemnosis* EDWARDS (1849) and *Spirulirostrella* NAEF (1921), apparently being unaware of WILTSHIRE's (1869) paper. NAEF (1922, p. 48, 49) subsequently included his new genus *Belemnosella* in the Belemnosidae and considered this genus as its most typical representative.

AVNIMELECH (1958, p. 63, 64) has strongly broadened the concept of Belemnosidae, emended the name into Belemnosisidae, and ascribed its authorship to himself. None of these actions is valid in my opinion. Like NAEF (1921, 1922), AVNIMELECH (1958) does not mention WILTSHIRE's (1869) paper and must have been unaware of its existence.

For reasons discussed below, the family Belemnosidae is here interpreted in the sense of NAEF (1922, p. 48), but with its spelling emended to Belemnoseidae (JELETZKY, 1966, p. 106). Of the four genera originally placed in Belemnosidae by WILTSHIRE (1869, p. 33) only *Belemnosis* can now be included in it. *Beloptera* and *Spirulirostra* have been made the type genera of other valid sepiid families by NAEF (1921) while the taxonomic position of *Helicerus* DANA (1849) remains obscure. This emendation of the spelling and the taxonomic concept of Belemnoseidae WILTSHIRE (1869) does not change its authorship under the Code of Zoological Nomenclature.

PHYLOGENETIC RELATIONSHIPS, MORPHOLOGY, AND TAXONOMIC STATUS.—Contrary to views expressed by NAEF (1922, p. 48-53, fig. 12-15, 101) and by me (JELETZKY, 1966, p. 88, 106), none of the Belemnoseidae genera, *Belemnosella* not excluded, can be considered as relatively unchanged descendants of the hypothetical root-stock of the Tertiary Sepiida.

In spite of the indubitably primitive structure of its phragmocone (JELETZKY, 1966, p. 88), *Belemnosella* appears to be a specialized form which is farther removed from the above-mentioned root-stock of the Tertiary Sepiida than *Vasseuria*. The latter genus combines an essentially similarly built phragmocone with a large, cup-like protoconch only indistinctly separated from the first camera, and a long, fairly broad, obtusely spatulate proostracum (JELETZKY, 1966, p. 66-67). Such a proostracum is unknown and apparently absent in all known representatives of Belemnoseidae, judging by the subtransverse course of the corresponding parts of conothecal striae on the conothecal surfaces of all studied specimens of *Belemnosella americana, B. floweri,* and *Belemnosis cossmanni*. Unlike *Vasseuria,* all better known representatives of Belemnoseidae possess a much smaller, spherically to elliptically shaped protoconch markedly separated from the first camera. *Vasseuria* possesses, furthermore, a thin, *Dentalium*-like sheath, completely devoid of a medioventral depression, lateral sublongitudinal furrows, and rounded sublongitudinal bulges characteristic of the sheaths of all Belemnoseidae, including *Belemnosella.*

All these morphological features indicate the rather strongly specialized nature of Belemnoseidae and their affinity with the families Belopteridae, Spirulirostridae, and even Belosepiidae, all of which appear to be completely devoid of the proostracum. It is concluded accordingly that it is not the Belemnoseidae but the taxonomically strongly isolated Vasseuriidae (and specifically *Vasseuria* itself) that are the least-changed descendants of the hypothetical root-stock of the Tertiary Sepiida, in spite of their considerable specialization in some important morphological features such as the organic (conchiolin) composition of septa, complex suture line, etc. (JELETZKY, 1966, p. 105-106).

Among contemporary or younger sepiid taxa, the Belemnoseidae are more closely related to Spirulirostridae than to any other sepiid family

known. Firstly, Spirulirostridae closely resemble Belemnoseidae in the following, taxonomically important morphological features:

1) Presence of an essentially Belemnoseidae-like medioventral depression on the alveolar part of the guardlike sheath. As already mentioned, the presence of a thin calcareous (aragonitic) sheath layer covering the surface of the conotheca within this depression is equally characteristic of Belemnoseidae and Spirulirostridae.

2) Presence of deep, fissurelike sublongitudinal furrows bordering the medioventral depression throughout its length and separating it from the adjacent more or less thickened parts of the sheath (sublongitudinal ventrolateral bulges).

3) Presence of an elongated or rounded, moundlike medioventral callus (=capitulum) containing the feebly to moderately incurved adapical part of the phragmocone either at the adapical end of the medioventral depression or in its middle.

4) Close morphological similarity of the phragmocone, including its cross section, apical angle, height of camerae, sutural pattern, and height in relation to that of the shell.

5) Presence of addorsally deflected spines at the apical end of the sheath. These spines are set off from a broader, rounded base and give a mucronate appearance to the sheath of Belemnoseidae and Spirulirostridae genera possessing them.

6) Apparently complete absence of a prostracum.

Secondly, Spirulirostridae are younger forms than the bulk of the Belemnoseidae which are common in the Eocene, but rare in the Oligocene. They are found in Miocene and, more rarely, Oligocene rocks. As pointed out by Berry (1922, p. 330), Naef (1922, p. 61, 67-68) was in error when placing the Australian *Spirulirostra curta* Tate (1893) in the Eocene.

Belemnoseidae differ from Spirulirostridae first of all in the complete absence of the salient ventrolateral flanges (=*Seitenflügel* of Naef, 1922, p. 96) of the dorsal shield. In Belemnoseidae these marginally sharpened flanges are invariably replaced by low, more or less regularly rounded ventrolateral sublongitudinal bulges (=*Seitenwülste* of Naef, 1922, p. 96) flanking the medioventral depression throughout its length. The presence of these rounded bulges and the complete absence of ventrolateral flanges is diagnostic of all known Belemnoseidae genera. No forms transitional toward Spirulirostridae in this respect are known so far, but it is assumed that the ventrolateral flanges of that family have evolved out of the rounded ventrolateral bulges of Belemnoseidae (see discussion of phylogeny of Belemnoseidae).

A second equally diagnostic distinction of the Belemnoseidae is considerably less marked endogastric curvature of the apicalmost part of their phragmocone. This curvature is restricted to the protoconch and the earliest few camerae only and it forms always less than one-quarter of a turn. The endogastric curvature of the apicalmost part of the Spirulirostridae phragmocone involves a longer segment and forms between one-half and one complete turn. This is true even of the oldest known and most primitive Spirulirostridae, *Spirulirostridium obtusum* Naef (1922, p. 62, fig. 21b-c,e).

The third, almost equally diagnostic distinction of Belemnoseidae consists in the transformation of the adapical part of the subtriangular medioventral depression into a deep and narrow fissure. This slitlike part of the depression subdivides the anterior slope of the low and ill-defined ventral callus into two. In some forms (e.g., *Spirulirostrella*) it extends right across the ventral callus (Naef, 1922, p. 50, fig. 13b). This slitlike extension of the medioventral depression is completely absent in all known representatives of the Spirulirostridae. In this family the medioventral depression narrows less rapidly adapically and mostly ends in a more or less narrow and deep, pitlike excavation. This depression is incised into the strongly elevated, adorally protruding ventral callus, which completely hides it from view in ventral aspect (Naef, 1922, p. 62-63, fig. 21a-c, 22b-c). Ridgelike lateral walls connect the above-described callus with the adoral parts of the ventrolateral expansions in the Spirulirostridae genera *(Spirulirostridium, Spirulirostra)* possessing the above-described excavation. However, this excavation is completely absent in *Amerirostra* though present in a rudimentary form in *Belemnosis cossmanni* Naef (see phylogenetical relationships of Belemnoseidae).

Other distinguishing features listed in the diagnosis of Belemnoseidae are rather less reliable. As pointed out in discussion of the phylogenetical relationships of Belemnoseidae and Spirulirostridae, the apical part of the sheath may be somewhat similarly shaped in otherwise dissimilar

representatives of these families. Generally speaking, however, the apical end of the Belemnoseidae sheath is considerably smaller and shorter than that of the Spirulirostridae. It tends, furthermore, to be either obtusely rounded (bosslike) to squarish or somewhat short conical and mucronate. Distinctly mucronate apical spines (=rostra) are common in Spirulirostridae and an obtusely rounded Belemnoseidae-like apical end occurs in *Spirulirostridium obtusum* NAEF which strongly reduces the taxonomical value of these sheath shapes.

The regularly convex surface of the thin sheath layer covering the bottom of the medioventral depression in all representatives of the Belemnoseidae is finely granulated and bears a number of very fine, closely spaced longitudinal furrows and ridges (see descriptions of *Belemnosella americana, B. floweri,* and *B.* n. sp., JELETZKY, aff. *B. floweri*). In *Belemnosis* (Pl. 1, fig. 1A) the more coarsely granulated surface of this layer bears instead a single considerably heavier medioventral ridge closely similar to that of *Spirulirostridium obtusum* (NAEF, 1922, p. 62, fig. 21a) and *Spirulirostra bellardi sepioidea* (NAEF, 1922, p. 66, fig. $24B_4$). Therefore, this sculpture is not at all diagnostic on the family level.

The variously shaped supplementary posterior protuberances occurring on the ventral sheath surface of some Spirulirostridae forms are likewise nondiagnostic on the family level. These supplementary protuberances are indeed absent completely in *Spirulirostra bellardi* while only feebly developed in a closely related form *S. bellardi sepioidea* (NAEF, 1922, p. 66, fig. 24A-B).

The above-mentioned morphological distinctions between Belemnoseidae and Spirulirostridae do not seem to contradict their inferred ancestor-descendant relationships. All appear to be evolutionary modifications and specializations of some details of fundamental morphological features common to the two families concerned.

For these reasons, and because of the presence of morphologically, stratigraphically, and apparently phylogenetically transitional forms between the families concerned, the Spirulirostridae are interpreted as direct descendants of the Belemnoseidae.

Of the known genera of Belemnoseidae, *Belemnosella* and *Spirulirostrella* most closely resemble Spirulirostridae (in particular *Spirulirostra*) in the following external features:

1) Gradually adapically tapering, subconical shape of the apical parts of their sheaths.

2) Presence of a well-delimited spine at the apical end of the sheath. In *Belemnosella* at least, this spine is feebly to markedly deflected dorsally.

3) Presence of a flat-topped, more or less markedly thickened dorsal shield ornamented with irregularly shaped granulae and pits.

Because of these points of similarity, NAEF (1922, p. 62) concluded that *Belemnosella* is directly ancestral to *Spirulirostra*. This conclusion is, however, contradicted by the entirely different shape and orientation of the *Belemnosella* phragmocone. As I have pointed out (JELETZKY, 1966, p. 106), this almost orthoconic phragmocone extends past the ventral callus (=capitulum) and enters the spinose apical end of the *Belemnosella* sheath. *Belemnosella* also differs from *Spirulirostra* and other representatives of the Spirulirostridae in the markedly triangular shape of its medioventral depression which gradually narrows and deepens adapically until it becomes slitlike on the adoral slope of the slightly elevated ventral callus which it divides in half. *Belemnosella* appears, therefore, to be a short-lived, peculiarly specialized side branch of the Belemnoseidae restricted to North America (Fig. 1). It apparently became homeomorphically similar to the Spirulirostridae in its above-mentioned external characteristics while retaining some primitive morphological features unique among the Belemnoseidae and presumably inherited essentially unchanged from the hypothetical common ancestors of the Groenlandibelidae and Tertiary sepiids (e.g., its almost orthoconic phragmocone extending into the apical end of the sheath), and acquired the characteristically Belemnoseidae-like, markedly triangular, posteriorly slitlike appearance of the medioventral depression which splits the anterior slope of the low ventral callus in two.

As previously stressed (JELETZKY, 1966, p. 106), nothing is known about the internal structure of *Spirulirostrella*. The genus is characterized, however, by the Belemnoseidae-like appearance of its medioventral depression and flanking longitudinal bulges, and by the extension of a fissurelike, adapical part of this depression right across the low, rounded ventral callus. These features and the peculiar adoral constriction of the sheath strongly suggest the aberrant nature of *Spirulirostrella*. Therefore it is interpreted as another specialized representative of the Belem-

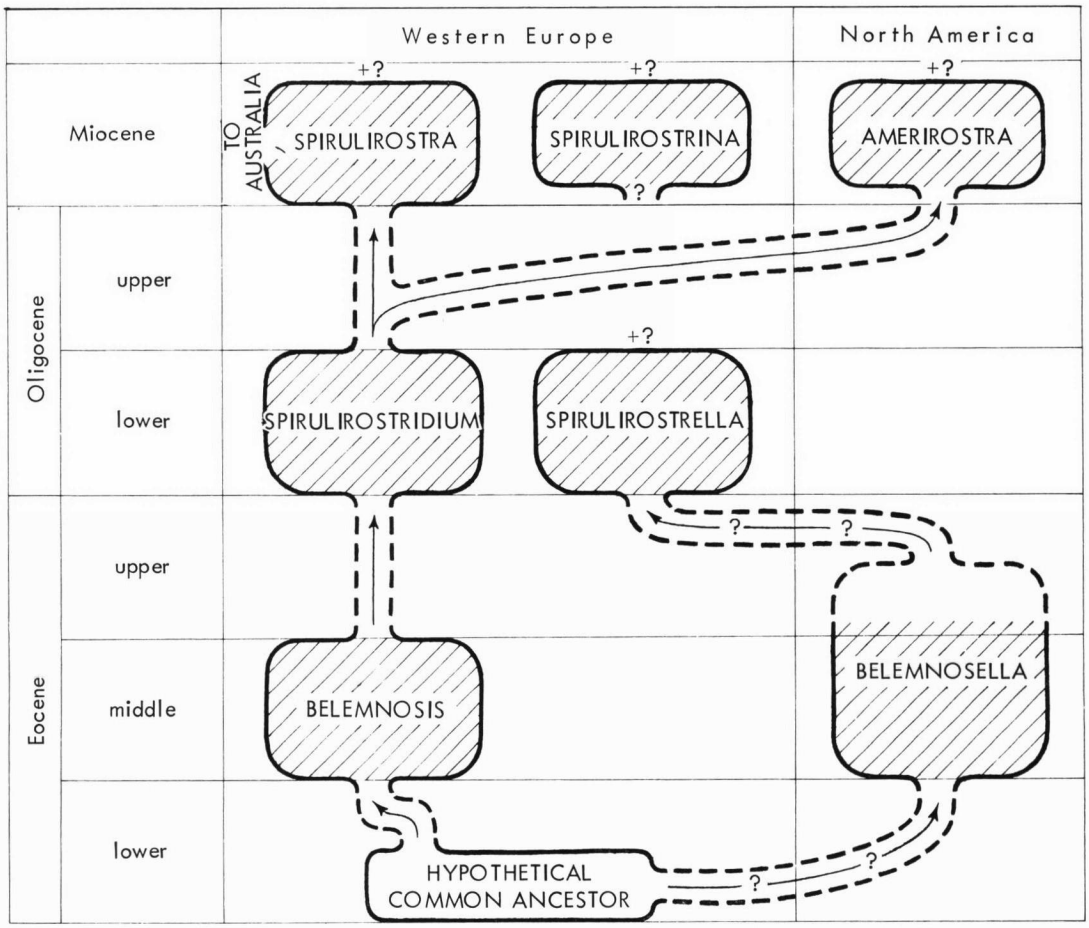


FIG. 1. Suggested phylogenetic relationships, time ranges, and migrations of known genera of Belemnoseidae and Spirulirostridae.

Time intervals from which at least some representatives of genera concerned are known are obliquely ruled and indicated in solid lines. Intervals from which no representatives of families concerned are known but during which they presumably existed are left blank and are outlined in dashed lines. Crosses with question marks placed at top of ranges of genera signify their presumed extinction. Vertical lines with arrows within each region indicate genetic relationships. Oblique lines with arrows crossing the regional boundary indicate inferred genetic relationships and migrations from western Europe to North America or vice versa.

noseidae possibly closely allied to and a direct descendant of *Belemnosella* (Fig. 1) but only homeomorphically similar to *Spirulirostra* and other genera of the Spirulirostridae.

In my opinion, *Belemnosis anomala* J. DE C. SOWERBY (1828) and the better preserved *B. cossmanni* NAEF (1922, see pl. 1, fig. 1A-1K) are more closely allied to the Spirulirostridae, and in particular to their oldest known representative, *Spirulirostridium obtusum* NAEF (1922, p. 61-62, fig. 21), than are either *Belemnosella* or *Spirulirostrella*. The apical part of the *Belemnosis* phragmocone is somewhat more strongly incurved endogastrically than that of *Belemnosella* and is embedded in the ventral callus much like apical parts of the phragmocones in all Spirulirostridae. Furthermore, the adapical part of the subtriangularly shaped medioventral depression of *Belemnosis* is considerably wider and shallower than that of *Belemnosella* and *Spirulirostrella*. In *B. cossmanni*

(NAEF, 1922, p. 51, fig. 14b, and this paper, Pl. 1, fig. 1A, 1L) the medioventral depression ends in a narrow and deep, pitlike excavation in the adoral slope of the ventral callus. Concomitantly, the adapical part of the medioventral depression subdividing the adoral slope of the ventral callus is a feebly developed depression rather than slitlike. Finally a short, relatively feeble, but otherwise *Spirulirostridium*- and *Spirulirostra*-like medioventral longitudinal ridge ornaments the surface of the covering sheath layer of the depression of *B. cossmanni* (Pl. 1, fig. 1A,D).

In *Belemnosis anomala* (EDWARDS, 1849, pl. 2, fig. 3b,c) the medioventral depression seems to end by gradual shallowing on the adoral slope of the rounded ventral callus without forming any adapical slit or pit. The marginal furrows of the depression also end blindly without becoming fused on the adoral slope of the rounded ventral callus. These peculiar, distinctly Spirulirostridae-like (specifically *Amerirostra*-like) morphological features of *B. anomala,* however, may be only the result of a strong post-mortem abrasion of the ventral callus of its only known specimen.

The many close morphological similarities of the lower Eocene to lower middle Eocene species of *Belemnosis* with the lower Oligocene *Spirulirostridium* suggest, contrary to NAEF's (1922, p. 61-62) opinion, that the latter genus evolved either from *Belemnosis* itself or from some as yet unknown *Belemnosis*-like representatives of Belemnoseidae through gradual development of salient ventrolateral flanges out of the low longitudinal bulges occurring in *Belemnosis* and other Belemnoseidae (Fig. 1). Other less significant evolutionary changes needed for transmutation of a *Belemnosis*-like form into a *Spirulirostridium*-like one appear to be restricted to increase of the endogastric curvature of the posterior part of the phragmocone, shortening of the ventral callus combined with increase of its elevation and development of a pronounced pitlike excavation behind it, complete disappearance of a medial depression on the adoral slope of the ventral callus, and increase in length of the postalveolar part of the sheath. These evolutionary changes are so minor that they would hardly be sufficient to justify removal of *Spirulirostridium* from the Belemnoseidae if they were not accompanied by the completely Spirulirostridae-like character of the ventrolateral flanges in this genus.

These considerations suggest that a majority of the Belemnoseidae are not directly ancestral to spirulirostrids but represent specialized, short-lived offshoots. Therefore, it seems more logical to maintain the Belemnoseidae as a separate family rather than to subordinate it as a subfamily of the Spirulirostridae (Fig. 1).

The Belopteridae, as exemplified by their best known (unfortunately strongly specialized) genus *Beloptera,* are rather unlike the Belemnoseidae, their similarity with this family apparently being restricted to presence of a morphologically similar phragmocone, apparent absence of the proostracum, and presence of pronouncedly salient ventrolateral flanges flanking the middle part of the sheath and somewhat resembling the ventrolateral bulges of the Belemnoseidae.

The Belopteridae differ from Belemnoseidae in the following important morphological features:

1) Large size and generally cuplike shape of the protoconch, which is only indistinctly separated from the first camera. This protoconch only differs from that of belosepiids in its greater depth. As in the Belosepiidae, morphology of the belemnoseid protoconch separates the latter sharply from belopterids and all other early Tertiary Sepiida possessing a medioventral depression on the alveolar part of the guardlike sheath, except for the descendent Spirulirostridae and Recent Spirulidae.

2) Presence of a distinct longitudinal thickening of the sheath in its medioventral zone. This thickened zone has the appearance of a low broad flat-topped ridge in *Beloptera.* In *Belopterina* it has the appearance of a narrow high ridge with a median longitudinal furrow in the middle of its flattened top (ROGER, 1952, p. 728, fig. 68,*2,* 68,*3*). The top of the ridge is broader than its base because of the presence of broadly rounded longitudinal depressions on the lower parts of its flanks. The ridge gradually widens and thickens adapically into a somewhat Belemnoseidae-like, low and rounded callus at the apical end of the above-mentioned furrow at its top. The presence of the thickened medioventral zone in the belopterid sheath indicates that the distinctly depressed medioventral zone of *Beloptera* is not homologous with the medioventral depression of the Belemnoseidae. Only the longitudinal furrow traversing the middle of the flattened top of the medioventral

ridge of *Belopterella* possibly could be homologous with the medioventral depression of belemnoseids and descendent spirulirostrids, all the more so as a low elongated mound possibly homologous to the ventral callus of the cited families occurs at the apical end of the furrow.

3) Entirely different shape of the postalveolar part of the sheath.

4) Presence of an individualized lateral depression of the sheath on each of its flanks (especially in *Belopterella*).

These profound morphological differences of the belopterid sheath as compared with that of the Belemnoseidae clearly indicate that the lateral flanges of the belopterid sheath are only homeomorphic with the ventrolateral bulges of the belemnoseid sheath. As indicated by the discovery of *Belopterella cylindrica* KOENEN (1885, p. 81, pl. 4, fig. 1a-e) in the Paleocene Kjerteminde marls of Denmark, the lateral flanges of Belopteridae *(Beloptera)* must have developed out of rounded longitudinal bulges homeomorphically similar to those of Belemnoseidae but situated mid-laterally on the strongly depressed sheath of primitive Belopteridae. Whether the strongly compressed *Belopterina* has developed out of the same ancestral forms as *Beloptera* is conjectural. If it did, the evolutionary trend *Belopterella-Belopterina* would parallel that leading from the more *Sepia*-like hypothetical common ancestor of Belosepiidae and Sepiidae toward *Belosepia*.

On the whole, Belopteridae seemingly should be interpreted as an independent, strongly aberrant but at the same time primitive offshoot of the hypothetical sepiid root-stock. This family must have branched off from this root-stock prior to the Belemnoseidae-Spirulirostridae lineage and developed somewhat convergently with the latter. This accounts for the homeomorphic similarity of the latest known representatives of Belopteridae (e.g., *Beloptera*) with the Belemnoseidae and Spirulirostridae.

The presence in *Belopterina* of possible homologues of the medioventral depression and ventral callus makes possible the assumption that the Belemnoseidae evolved out of some early Paleocene (Danian?) *Belopterina*-like forms. However, any such hypothetical lineage leading from *Belopterina*-like forms toward Belemnoseidae and then to Spirulirostridae would have evolved in an entirely different direction from that leading toward *Beloptera* and (?) *Belopterella*. If so, the above-discussed medioventral furrow of the ancestral forms concerned must have become transformed into the adorally much wider but subtriangular, adapically slitlike narrowing depression characteristic of all known Belemnoseidae. Another morphological modification involved would have been the development of rounded longitudinal bulges flanking the medioventral depression and the apparently correlative development of narrow and deep longitudinal furrows at the boundaries between these two morphological elements of the sheath. The spheroidal to elliptical adorally constricted protoconch would have evolved out of the cuplike one at the same time.

Genus BELEMNOSELLA Naef, 1922

[=*Advena* PALMER, 1937; *Anevda* PALMER, 1940 (subj.)]

TYPE SPECIES.—*Belemnosis americana* MEYER & ALDRICH, 1886 (by monotypy).

DIAGNOSIS.—Phragmocone long and straight, except for protoconch and earliest 2 or 3 camerae, which are feebly incurved endogastrically, extending past ventral callus (=capitulum) to reach base of apical spine of guardlike sheath, which is deflected weakly to strongly toward dorsal side.

STRATIGRAPHICAL RANGE.—Middle Eocene, Cook Mountain Form. (type) and Gosport Sand (type); upper and uppermost Claiborne Group (PALMER & BRANN, 1965, p. 376-377).

GEOGRAPHICAL OCCURRENCE.—Southeastern United States (Mississippi, Alabama).

SYNONYMY.—See JELETZKY, 1966 (p. 106-107).

DISCUSSION.—A detailed study of the holotype and only known representative of *Belemnosella americana* has necessitated amendment of MEYER & ALDRICH's (1886) description of the shape and direction of its phragmocene, previously accepted as valid by me (JELETZKY, 1966, p. 106). As pointed out below in describing *B. americana,* the protoconch and earliest 2 or 3 camerae are feebly incurved endogastrically. *Belemnosella* appears therefore to be more closely allied to *Belemnosis* than formerly believed (JELETZKY, 1966, p. 107), all the more so since other species of *Belemnosella* (*B. floweri, B.* n. sp., JELETZKY, aff. *B. floweri*) apparently possessed somewhat more incurved apicalmost parts of the phragmocone and considerably shorter ventral calluses. Study of the conothecal striae of *B. americana* and *B. floweri* indicates, furthermore, that *Belemnosella* apparently lacked a proostracum and that its mouth border was *Spirula*-like. These findings are included in

the emended diagnosis of *Belemnosella* provided in this paper. The phylogenetical reappraisal of *Belemnosella* has been given in connection with discussion of the Belemnoseidae.

The apparently younger age and morphologically more advanced appearance of *Belemnosella floweri* as compared with *B. americana* are suggestive of their ancestor-descendant relationships. *B.* n. sp., JELETZKY, aff. *B. floweri* does not seem to fit into this possible *Belemnosella* lineage regardless of its still unknown stratigraphic position within the upper Claiborne Group.

The circumstance that the three *Belemnosella* specimens known so far appear to be referable to as many species is certainly peculiar. It suggests that *Belemnosella* occurs at several levels within the upper Claiborne Group and is not as rare in these rocks as the present data would suggest.

Belemnosella americana (Meyer & Aldrich, 1886)

Figure 2; Plate 1, figures 2A-J

1886, *Belemnosis Americana* MEYER & ALDRICH, 1886, p. 47, pl. 2, fig. 26-26a.

1922, *Belemnosella americana* NAEF, p. 49, fig. 12.—1941, STENZEL, p. 90.—1965, PALMER & BRANN, p. 376.—1966, JELETZKY, p. 106-107.

1937, *Advena Americana* PALMER, p. 511, pl. 76, fig. 13-14.

DIAGNOSIS.—Ventrolateral bulges rounded and dorsolateral shoulders subangular throughout their length; more or less straight to slightly concave flanks converging adorally throughout length of sheath, resulting in regularly subangular more or less trapezoidal cross sections of latter; almost flat dorsal side of sheath expanding adorally at about 20 degrees; ventral callus considerably longer than wide, not expanding adlaterally, ill-defined, this callus protruding adventrally much less and situated relatively farther from base of apical spine than that of *Belemnosella floweri*; sheath considerably less depressed and irregularly rugose sculpture of its dorsum considerably finer and lower than those of *B. floweri*.

MATERIAL AND TYPE SPECIMEN.—One nearly complete specimen (holotype by monotypy), originally described and figured by MEYER & ALDRICH (1886, p. 47, fig. 26-26a) and restudied by me (JELETZKY, 1966, p. 106-107, and this paper). It is preserved in the United States National Museum collections (no. 638750), Washington, D.C. No additional specimens of *Belemnosella americana* were available to me when this paper was written.

STRATIGRAPHIC POSITION AND AGE.—According to PALMER & BRANN (1965, p. 376) the holotype and only known specimen of *Belemnosella americana* is from the Cook Mountain Formation (type), upper Claiborne Group, Wautubbee (type), Clarke County, Mississippi; it is middle Eocene in age.

Description

GUARDLIKE SHEATH.—The almost complete sheath of the holotype (and only known representative) of *Belemnosella americana* is about 26.6 mm. long (actual length). The missing apical spine (=rostrum of PALMER, 1937, p. 510), presumably deflected addorsally (as in *Belemnosella floweri;* see Pl. 1, fig. 2A-H), probably would add another 2.5 to 3.0 mm. to its total length. Another 1.5-2.0 mm. should be added by the restoration of the broken-off central part of the broadly spatulate adoral end of this specimen (Pl. 1, fig. 2A,D,G). This gives an estimated total length of 30.6 to 31.6 mm. and a ratio of estimated total length to maximum lateral diameter of $\simeq 3.35$.

In ventral aspect (Pl. 1, fig. 2A,D) the sheath is broadly and obtusely linguliform in its adoral 7 to 7.5 mm. There its margins converge rapidly and increasingly fast toward the central part of the dorsum, forming a symmetrical, broadly rounded dorsal protuberance. As already mentioned, some 1.5 to 2.0 mm. of the oral end of this protuberance is broken away from the middle of the dorsum. In the dorsolateral quadrants, however, the protuberance is virtually complete, as thickness of the sheath at its oral margin does not exceed 0.5 mm.

From the level of its maximum lateral diameter (about 9.1 mm.) which occurs about 7.4 mm. adapically of the oral end, the sheath tapers gradually and more or less evenly all the way to the broken-off base of the apical spine (Pl. 1, fig. 2A,D).

The shape of the break in the apical spine of *Belemnosella americana* in the only known specimen indicates clearly that it was set off more markedly from the main sheath body than is denoted by its restoration in the original drawings (MEYER & ALDRICH, 1886, pl. 2, fig. 26-26a). Also apparently it was somewhat more deflected addorsally than suggested by these drawings. My judgment as to the probable shape, dimensions, and orientation of this apical spine are indicated in Figure 2.

Nevertheless, the apical spine of *Belemnosella americana* probably was considerably smaller, less

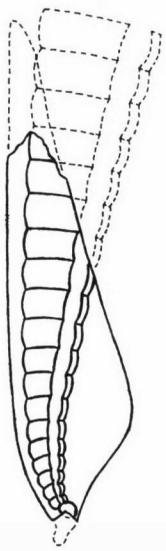


FIG. 2. Diagrammatic reconstruction of complete shell of *Belemnosella americana* (MEYER & ALDRICH, 1886), ×2.5. Cross section of sheath and phragmocone in lateral aspect (actually preserved parts of shell shown in solid lines; reconstructed parts shown in dashed lines). No attempt has been made to reproduce exactly structural details of septa and siphuncle.

addorsally deflected, and less markedly set off from the main body of the sheath than in *B. floweri*.

The ventral surface of the sheath is regularly but narrowly rounded in its apical quarter. As it gradually widens adorally from the broken-off apical end, the rounded ventral face of the sheath swells up in lateral aspect into a markedly adventrally protruding, but ill-defined oval longitudinally elongated protuberance—the ventral callus (JELETZKY, 1966, p. 62, 106). Maximum swelling of the ventral callus occurs about 6.4 mm. adorally of the broken apical end of the sheath where the latter reaches its maximum dorsoventral thickness of 7.1 mm. (Pl. 1, fig. 2A,D). The ratio of distance between base of spine and top of ventral callus to inferred length of the sheath is about 0.18.

In lateral aspect the ventral callus is somewhat larger and considerably more strongly swollen than is shown in the original drawing of *Belemnosella americana* (compare MEYER & ALDRICH, 1886, pl. 2, fig. 26a, and this paper, Pl. 1, fig. 2B,E-F). Nevertheless, it is considerably longer than wide, hardly expands adlaterally at all, is ill-defined, and protrudes rather feebly adventrally (as compared with ventral callus of *B. floweri* and *B.* n. sp., JELETZKY, aff. *B. floweri*, Pl. 2, fig. 1A,D, 2A,D).

In lateral aspect the ventral surface of the sheath tapers both adorally and adapically from the level of its maximum dorsoventral diameter. The latter coincides with the point of maximum thickening and enlargement (i.e., top) of the ventral callus (Pl. 1, fig. 2B,E-F). The adapical tapering is much more rapid than the adoral tapering and the ventral surface of the sheath is at first distinctly convex and then somewhat concave between the top of the ventral callus and the broken apical end of the sheath. The adoral tapering of the ventral surface proceeds much more slowly and more or less evenly, except for the adoralmost 3.5-4.0 mm. of the sheath where its rate increases abruptly.

Adorally of the ventral callus, the alveolar two-thirds of the ventral side of the sheath is largely occupied by a more or less triangularly shaped depressed area. In the adoral third of the sheath this depression occupies all of the ventral side. Near the oral end of the specimen the depression is only flanked by broken ventrolateral walls of the sheath, exposing a cross section of the conotheca and thin covering of the sheath. Farther adapically the medioventral depression narrows gradually and becomes more and more markedly depressed. As it narrows and deepens adapically, the medioventral depression becomes flanked by gradually widening and thickening, rounded ventrolateral longitudinal bulges of the sheath. These merge into the flattened flanks but are sharply separated by deep fissurelike furrows from the above-mentioned conotheca and sheath layers lining the bottom of the medioventral depression. On the adoral slope of the ventral callus the medioventral depression becomes slitlike and deeply incised just before its now vertical walls run together (Pl. 1, fig. 2A,D,I,J), closely before the top part of the callus. The ventrolateral longitudinal bulges reach their maximum width and height at this point, just before they merge into the top part of the ventral callus. The depth of the medioventral depression at its apical end is estimated to reach about one-third of the maximum dorsoventral diameter of the sheath. The length of the depression is about 18.3 mm., while the length of the part of the sheath behind the depression is about 8.3 mm.

The thin shell layer lining the medioventral depression does not consist solely of conotheca, as previously believed (JELETZKY, 1966, p. 106, in diagnosis of Belemnoseidae). As clearly visible in cross sections near the strongly incised slitlike apical end of the depression under magnification of ×10, the surface of the nacreous (shiny), 0.2-0.3 mm. thick, white-colored conotheca is covered by a brownish-gray, densely radially prismatic sheath layer about 0.8-0.9 mm. thick. This covering sheath layer is very sharply delimited from the conotheca wherever the two are visible in cross section. Farther adorally, small fragments of the conotheca and covering sheath layer are only locally preserved at margins of the depression (Pl. 1, fig. 2A,J). However, their rims are clearly visible in cross section all along its margins and there seems little doubt that the covering sheath layer was originally superimposed on the conotheca throughout most or all of the surface of the medioventral depression. It seems obvious that the oral margin of the covering sheath layer was situated only slightly adapically of the adoral margins of the lateral and dorsal portions of the sheath.

In the adoral 6-7 mm. of the medioventral depression, the covering sheath layer gradually thickens adlaterally and so merges imperceptibly into the considerably thicker sheath layer of the flanks. Farther adapically, however, well-defined fissurelike single furrows, 0.4-0.6 mm. wide and similarly deep, appear on each side of the medioventral depression between the covering sheath layer and the rounded ventrolateral bulges of the sheath. The walls of these furrows are oriented obliquely outward (i.e., toward dorsolateral surfaces of the sheath). The furrows themselves become gradually deeper in adapical direction as the ventrolateral bulges become wider and wider and more elevated (Pl. 1, fig. 2A,D). The covering sheath layer of the medioventral depression appears to form deep narrow folds beneath the furrows before merging into the sheath layer of the ventrolateral bulges. However, the depth and other details of the morphology of these folds remain partly obscure because of the lack of suitable cross sections of the sheath. In middle parts of the depression the furrows widen locally to 0.8-1.0 mm. and well-defined, apparently similarly high, round-topped ridges 3-4 mm. long and 0.2-0.3 mm. wide appear inside them (Pl. 1, fig. 2A). The ridges disappear farther adapically as the furrows narrow again to 0.2-0.3 mm. and deepen considerably as compared with their adoral parts.

Wherever it is preserved near the apical end of the medioventral depression or its margins, the surface of the covering sheath layer appears smooth to the naked eye. At magnifications of ×10 to ×15, however, it is seen to be covered by a great number of fine, closely spaced longitudinal ridges separated from each other by similarly fine and closely spaced furrows.

The ventral surface of the sheath, including that of its ventrolateral bulges, appears to be extremely finely corrugated to the naked eye under favorable light conditions (Pl. 1, fig. 2D) or otherwise almost smooth. At magnifications of ×10 to ×15 it appears to be finely granulated. The individual granules are more or less rounded and arranged in subtransverse, corrugated rows. This produces a generally shagreenlike appearance. The same is true of the steep to vertical walls of the medioventral depression within its adapical slitlike quarter. The only exception is a small area of the ventral surface surrounding the apical end of the medioventral depression (Pl. 1, fig. 2A,J). There the surface of the sheath is covered by fine irregularly rounded closely spaced tubercles commonly flat-topped (because of abrasion) and mostly separated from each other by irregularly shaped small pits or vermiform grooves. These structural elements are visible to the naked eye. The semitransparent nature of the sheath makes it possible to see that the tubercles are, in fact, protruding parts of spheroidal oolitelike bodies. These dirty white-colored and apparently well-calcified spheroidal bodies are imbedded in a light-gray structureless, presumably less strongly calcified or predominantly organic (conchiolinic?) matrix, at least in part. The pits and grooves between the spheroidal bodies were presumably once filled by the latter matrix. The general structure is the same as that described in *Amerirostra americana* and its origin is presumably identical. The apparent restriction of the tuberculation to the above-described small area of the ventral surface of the sheath is probably due to removal of its dense finely corrugated sheath layer.

In lateral aspect (Pl. 1, fig. 2B,E,F) the dorsal surface of the sheath is more or less straight and

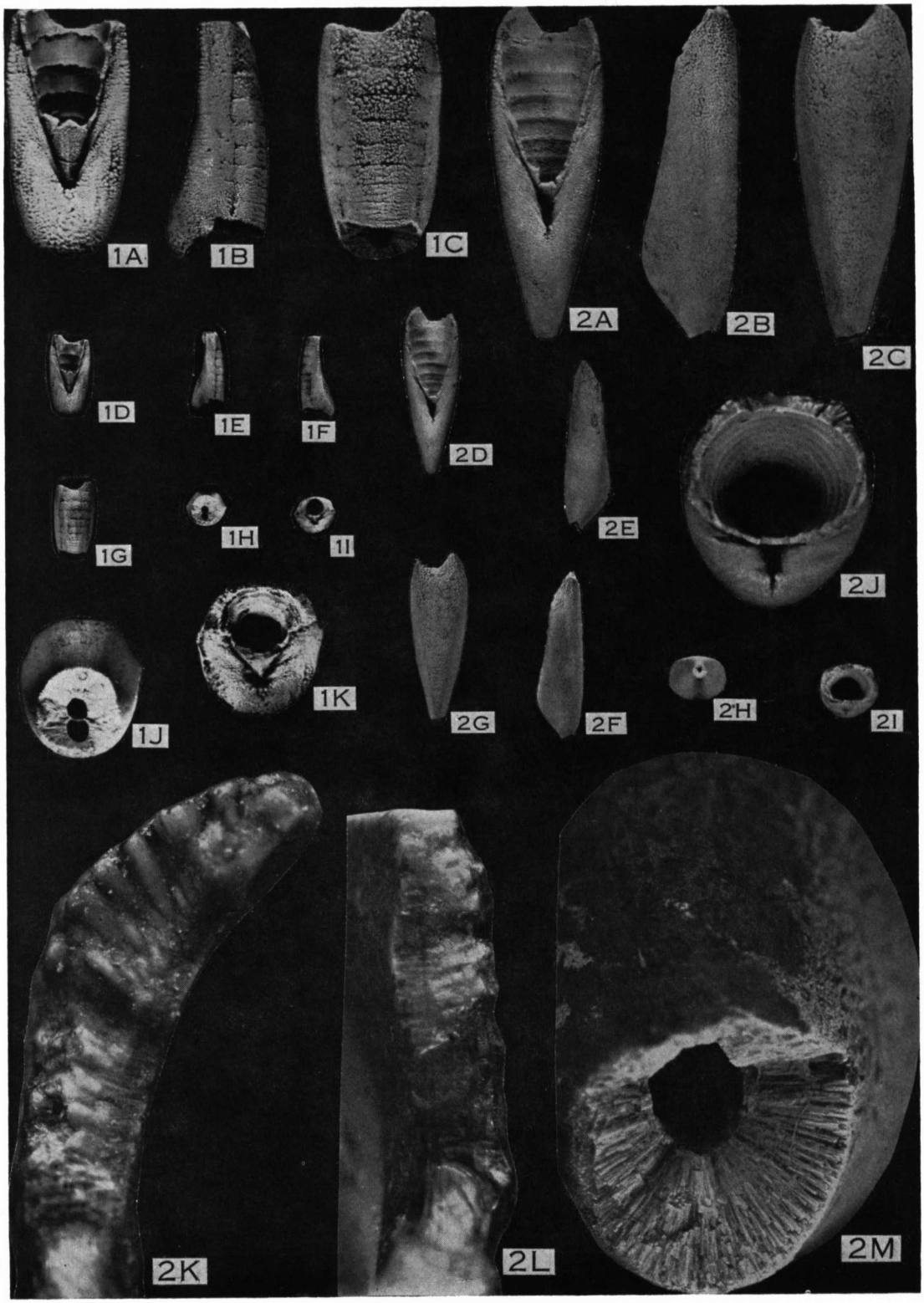
parallel to its longitudinal axis, except in the adoralmost and adapicalmost parts where the sheath begins to contract rapidly. The dorsal surface becomes markedly convex in lateral aspect in the adapicalmost 3 mm. of the sheath (Pl. 1, fig. 2B). This curvature reflects the endogastric curvature of the corresponding part of the phragmocone. The less-marked contraction of the adoralmost 2.5 mm. of the sheath in lateral aspect is caused by the rapid thinning of the sheath. This could possibly be a secondary phenomenon, judging by the deeply weathered appearance of the sheath surface there.

The flanks of the sheath are oriented obliquely to the plane of its symmetry. They converge addorsally, forming angles of about 30 degrees with this plane (Pl. 1, fig. 2H) throughout the adapical four-fifths of the sheath. In the adoral one-fifth this obliquity decreases gradually until it becomes slight at the oral end of the sheath (Pl. 1, fig. 2I-J). The maximum lateral diameters of the sheath, therefore, are situated at its subangular ventral margin throughout its length. This results in a markedly depressed (depression ratio, i.e., lateral diameter (8.4 mm.) to dorsoventral diameter (5.6 mm.), =1.5 in the middle of

EXPLANATION OF PLATE 1

FIGURE

1. *Belemnosis cossmanni* NAEF, 1922, middle Eocene (lower Lutetian), Bois Gouet, Françe (Mus. Roy. Sci. Nat. de Belgique, no. I.G. 10591).——A. Ventral view (×3) showing the stumps of dorsal parts of septa and imprints of subtransverse conothecal lines on inner surface of conotheca; granulated and longitudinally keeled surface of thin covering sheath layer within medioventral depression clearly visible.——B. Right lateral view (×3) (for shape of broken-off part of apical end see NAEF, 1922, p. 51, fig. 146).——C. Dorsal view (×3); transverse furrows covering flattened dorsal part of sheath and addorsal portions of flanks (compare Fig. 1A) occur more or less opposite suture lines of phragmocone and could represent their imprints transmitted through sheath in same way as are conothecal growth lines of Aulacoceridae (JELETZKY, 1966, p. 17-18).——D. Same view as in A (×1).——E. Same view as in B (×1).——F. Left lateral view (×1).——G. Same view as in C (×1).——H. Apical view (×1) showing cross section of protoconch and first camera in break at apical end.——I. Alveolar view (×1) showing almost regularly circular cross section of alveolus, keeled and granulated appearance of thin covering sheath layer, and adapical convergence of ventrolateral bulges and of medioventral furrow in pitlike excavation sunk into adoral slope of ventral callus.——J. Same view as in H (×3) showing finer detail of apical end, protoconch, and first camera.—K. Same view as in I (×3.5) showing finer detail of oral end of sheath and its ventral surface (shallow, depressionlike appearance of apical end of medioventral depression crossing middle of anterior slope of ventral callus clearly visible contrasting with its slitlike character in *Belemnosella americana,* Fig. 2J).
2. *Belemnosella americana* (MEYER & ALDRICH, 1886), holotype, middle Eocene, Cook Mountain Form. (type), upper Claiborne Group. Wautubbee (type), Clarke Co., Mississippi (USNM no. 638750).——A. Ventral view (×2) showing regular *Spirula-* and *Groenlandibelus*-like transverse corrugations of the conotheca and subtransverse conothecal growth lines.——B. Right lateral view (×2); apical spine completely broken off.——C. Dorsal view (×2).——D. Same view as in A (×1).——E. Left lateral view (×1).——F. Same view as in B (×1).——G. Same view as in C (×1).——H. Apical view (×1) showing cross section of endogastrically incurved protoconch in break at apical end.——I. Alveolar view (×1) showing subangular, somewhat trapezoidal shape of the alveolar end and markedly depressed cross section of alveolus; photograph taken before sediment was removed from slitlike adapical part of medioventral depression (compare 2J).——J. Same view as in I (×4) showing finer detail of alveolar walls and ventral surface of sheath; transversely corrugated appearance of outer surface of conotheca (imprint) clearly visible, adapical slitlike part of medioventral depression splitting adoral slope of ventral callus into two symmetrical parts.——K. Cross section of right side of broken-off part of alveolar end of sheath visible as irregularly limited embayment in 2A (×24 approx.); conotheca not preserved anywhere, inner one-quarter to one-fifth of sheath cross section consisting of transversely prismatic and concentrically laminated, uniformly calcified material; outer three-quarters to four-fifths of cross section exhibits different structure described in text.——L. Cross section of left side of broken part of alveolar end of sheath, right side of which is shown in K (×24 approx.); concentrically laminated and radially prismatic structure of inner part of sheath cross section and its sharp delimination from differently structured outer part clearly visible.——M. Apical view of broken base of apical spine showing cross section of protoconch and pronouncedly radially prismatic structure of guardlike sheath (×16 approx.).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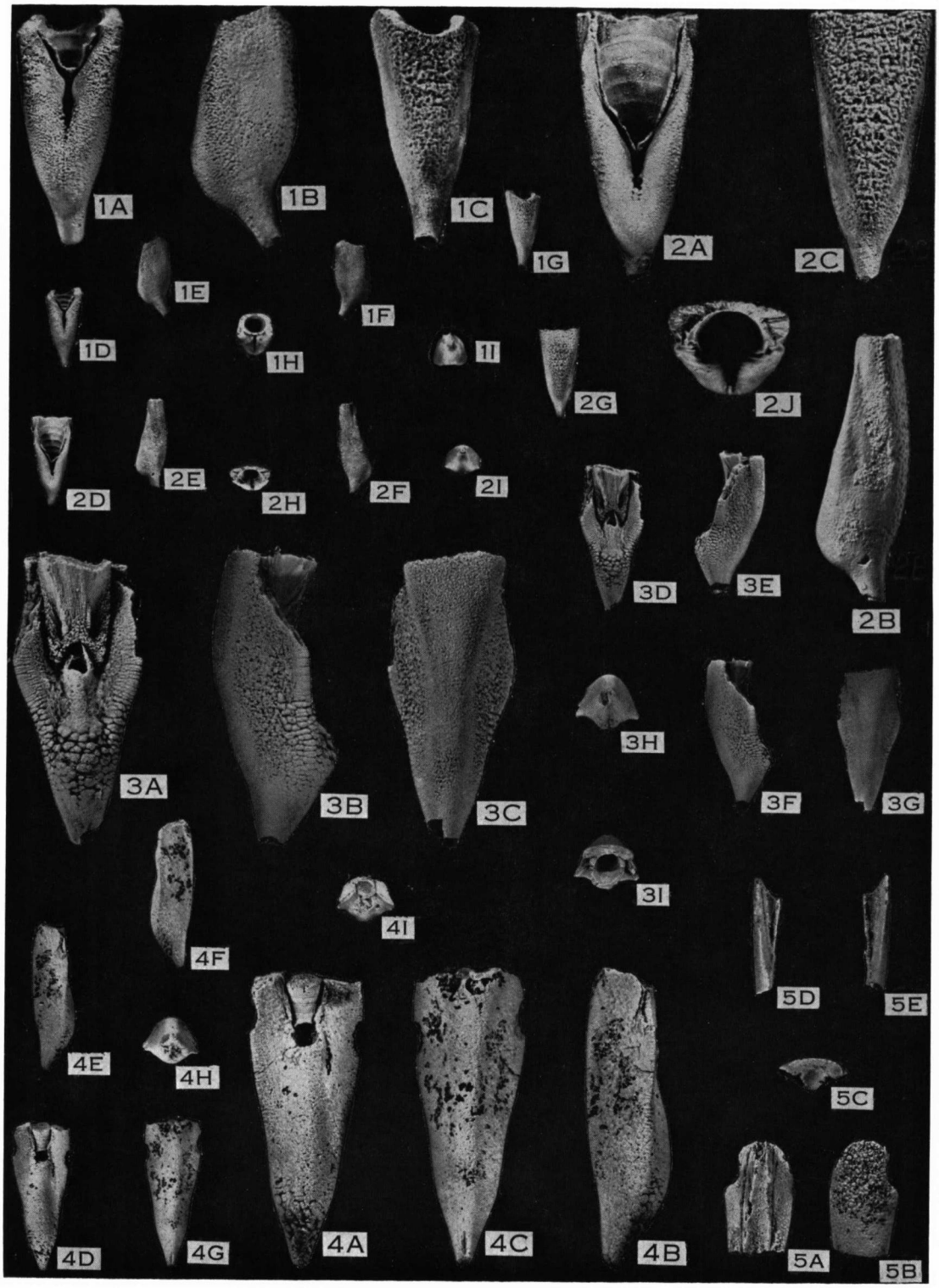
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the sheath), trapezoidal, subangular cross section of the sheath (Pl. 1, fig. 2I-J) in its adoral three-quarters. The depression ratio gradually decreases from the oral end of the specimen until the cross section becomes first equidimensional and then compressed in the adapicalmost 6.0 mm. long section (Pl. 1, fig. 2H). Within this adapical section the sheath has a strongly compressed [compression ratio, i.e., lateral diameter (5.1 mm.) to dorsoventral diameter (7.2 mm.), =0.70 at the level of maximum expansion of ventral callus], egg-shaped cross section, the wider end of which is on the ventral side.

Ill-defined, very shallow longitudinal depressions occur at the dorsal margins of the flanks. These 1.5-2 mm. wide depressions essentially parallel the subangular shoulders separating the flanks from the flattened dorsum throughout the length of the sheath. They become barely distinguishable, however, just before its apical and oral ends. No secondary furrows or ridges are clearly discernible either on the bottoms or sides of these

EXPLANATION OF PLATE 2

FIGURE

1. *Belemnosella* n. sp., JELETZKY, aff. *B. floweri* (PALMER, 1937), middle Eocene, Claiborne Group, Alabama; exact locality and formation unknown (Coll. Geol. and Paleont. Dept., Acad. Nat. Sci. Phila., no. 10041). ——A. Ventral view (×3).——B. Right lateral view (×3).——C. Dorsal view (×3); much greater relative size of apical spine as compared with that of *B. floweri* (compare 2C) well displayed.——D. Same view as in A (×1).——E. Same view as in B (×1). ——F. Left lateral view (×1).——G. Same view as in C (×1).——H. Alveolar view (×1); note considerably more narrow and longer slitlike apical part of medioventral depression and complete absence of dorsolateral bulges of sheath.——I. Apical view (×1); note markedly compressed cross section of apical part of sheath and strong addorsal deflection of apical spine which sharply differentiate our form from holotype of *B. floweri* (compare 2I).
2. *Belemnosella floweri* (PALMER, 1937), holotype, middle Eocene, Gosport Sand (type), uppermost Claiborne Group, Claiborne Bluff, Alabama River, Monroe Co., Alabama (Paleont. Research Inst. no. 3402).——A. Ventral view (×3).——B. Right lateral view (×3). ——C. Dorsal view (×3).——D. Same view as in A (×1).——E. Same view as in B (×1).——F. Left lateral view (×1).——G. Same view as in C (×1). ——H. Alveolar view (×1).——I. Apical view (×1). ——J. Same view as in H (×3) showing detail of adoral cross section and ventral side of sheath.
3. *Amerirostra americana* (BERRY, 1922), lectotype, apical half of adult sheath; Miocene, Santa Rosa, Vera Cruz, Isthmus of Tehuantepec, southern Mexico (USNM no. 644841a).——A. Ventral view (×2).—— B. Left lateral view (×2).——C. Dorsal view (×2). ——D. Same view as in A (×1).——E. Right lateral view (×1).——F. Same view as in B (×1).——G. Same view as in C (×1).——H. Apical view (×1) showing supplementary adapical ventral callus and ventrolateral flanges.——I. Alveolar view (×1) showing cross section of gently convex dorsal shield, apparently sharp separation of dorsal shield's flanks from flanges an illusion caused by incompleteness of adoral parts of latter.
4. *Amerirostra americana* (BERRY, 1922), apical half of shell of slender variant (half-grown specimen?) which retains well-preserved fragment of phragmocone and complete apical spine, same age and locality as for lectotype reproduced in Fig. 3 (USNM no. 644842a). ——A. Ventral view (×2); relatively much greater slenderness of sheath and much more feeble development of ventrolateral flanges believed to be infraspecific distinctions.——B. Left lateral view (×2); elongated shape and much smaller adventral protrusion of ventral callus and smaller addorsal deflection of relatively shorter apical spine believed to be infraspecific distinctions.——C. Dorsal view (×2).——D. Same view as in A (×1).——E. Same view as in B (×1).——F. Right lateral view (×1).——G. Same view as in C (×1).——H. Apical view (×1); venter down.——I. Alveolar view (×1).
5. *Amerirostra americana* (BERRY, 1922), same age and locality as for lectotype reproduced in Fig. 3 (USNM no. 644841b). Oral outgrowth of dorsal shield of presumably adult sheath possibly belonging to same specimen as fragment USNM no. 644841a reproduced in Fig. 3.——A. Ventral view (×1); ventral buttress clearly visible.——B. Dorsal view (×1); dense, glazed outer sheath layer covering adapical third of surface almost absent farther adorally, this part of outgrowth surface mostly exposing subjacent spongy and cavernous matter rich in oolitelike, rounded to budlike, better-calcified bodies.——C. Apical view (×1) showing apical cross section of outgrowth; because of optical illusion surface of ventral buttress appears as rounded concave body underneath cross section of outgrowth.——D. Left lateral view (×1) showing concave left side of ventral buttress (on right side of photograph).——E. Right lateral view (×1) showing concave right side of ventral buttress (on left side of photograph).

depressions. Adventrally of the depressions flanks of the sheath become somewhat convex, especially in proximity to the ventral callus.

On the adapical half to two-fifths of the flanks the surface of the sheath largely appears to be sculptured in the same way (to the naked eye) as on its ventral surface. Also at magnifications ranging from ×10 to ×15 these parts of the flanks mostly exhibit the same transversely corrugated rows of granules and have the same shagreenlike appearance as does the ventral surface of the sheath. A number of irregularly shaped and distributed small pits are present locally, however. In several places are indications of the tuberculate and pitted structure of the sheath surface, such as occur in one restricted area on the ventral side of the sheath. For reasons given below, I believe that this tuberculate structure may be present elsewhere on the parts of the flanks here discussed but it is completely concealed by the dense, transversely corrugated outermost layer of the sheath.

Farther adorally on both flanks the nearly smooth to finely corrugated sculpture of the sheath's surface commonly is replaced by the finely tubercular, pitted, and irregularly grooved sculpture clearly visible to the naked eye. The latter type of structure generally is restricted to the more strongly weathered parts of the flanks and the two types of sculpture alternate quite disorderly.

The adoral one-third to two-fifths of both flanks are almost completely covered by still coarser, mostly irregularly rounded tubercles which are very closely spaced or almost in contact with one another (Pl. 1, fig. 2B,E,F). These tubercles are separated from each other by small irregularly shaped shallow pits and fine vermiform grooves. All three structural elements are clearly visible to the naked eye. In places where the surface of the sheath is strongly abraded, the cross sections of beveled dirty white, obviously strongly calcified tubercles exhibit a distinct oolitic structure. The only slightly depressed pits and grooves between them are in such cases partly filled out by a homogeneous to irregularly crystalline, gray to rust-colored substance. This sculpture is identical with that previously described on the ventral surface of the sheath in proximity to the medioventral depression (Pl. 1, fig. 2A,D). The spheroidal character of the "tubercles" is quite obvious in several places where the apparently only partly calcified to (?) largely organic, darker-colored substance separating them is completely removed to a greater depth than elsewhere.

Small areas partly exhibiting the glazed, transversely corrugated sheath surface occur between much larger areas covered by the tuberculate, pitted and grooved sheath surface and the latter type of sculpture may locally disappear under the former type. This indicates that the tuberculate, pitted and grooved structure of the sheath's surface is caused either by weathering or by abrasion of the inner sheath's layers, such weathering commencing only when the dense, well-calcified outermost sheath layer was completely destroyed by weathering or abrasion. It is actually possible to see in places the spheroidal oolitelike bodies and the intervening darker-colored matter of the inner sheath's layers through the attenuated semitransparent outermost sheath layer.

The dorsal sheath surface is regularly but gently convex, except in the adapicalmost 2.5 to 3 mm. where it is narrowly but obtusely rounded (Pl. 1, fig. 2A,H). Farther adorally the width of the flattened dorsal sheath surface increases gradually to a point about 5 mm. from the sheath's oral end, its margins forming an angle of about 20 degrees (Pl. 1, fig. 2C,G). Yet farther adorally the surface contracts rapidly to the oral end of the sheath. This results in the broadly and obtusely spatulate shape of the oral end of the sheath in dorsal aspect (Pl. 1, fig. 2C,G), a shape closely resembling that seen in ventral aspect.

The flattened dorsal sheath surface is limited on both sides by clearly defined subangular shoulders which separate it from the generally adlaterally sloping but slightly depressed adjoining parts of the sheath's flanks (Pl. 1, fig. 2H-J). These shoulders are about equally sharply delimited throughout the length of the flattened dorsal sheath surface (Pl. 1, fig. 2C,G).

Contrary to PALMER's (1937, p. 511) statement, the dorsal surface of the holotype of *Belemnosella americana* does not lack the pronouncedly and relatively coarsely rugose sculpture such as occurs in the holotype of *B. floweri* (Pl. 1, fig. 2C,G; Pl. 2, fig. 1C,G). This statement appears to be a *lapsus calami*. PALMER (1937, p. 512) pointed out that she did not see the holotype of *B. americana* and it was only figured in ventral and lateral aspects in its original publication

(MEYER & ALDRICH, 1886, p. 47, pl. 2, fig. 26-26a). Furthermore, there is no mention of the sculpture of the sheath's surface in the brief original diagnosis of *B. americana*.

As a matter of fact, the dorsum of *Belemnosella americana* for the most part is fairly irregularly and coarsely rugose (Pl. 1, fig. 2C,G). This sculpture only differs from that of *B. floweri* (Pl. 2, fig. 2C,G) in the somewhat lesser relief and smaller dimensions of its individual elements. The irregularly and fairly coarsely rugose parts of the *B. americana* dorsum (Pl. 1, fig. 2C) do not exhibit well-defined tubercles or spheroidal, oolite-like bodies, presumably because of the profound weathering and alteration of these parts of the guardlike sheath. However, the rugose sculpture grades imperceptibly into the tuberculate, pitted and grooved sculpture in proximity to the shoulders and at the oral end of the dorsum (Pl. 1, fig. 2B-C).

On the whole, it is likely that the various previously described types of sculpture observed on the sheath surface of *Belemnosella americana* reflect largely or entirely the degree of its weathering and abrasion. Therefore, they do not seem to be taxonomically valuable even on the subspecific level, except for the transversely corrugated rows of extra fine tubercles observed whenever the sheath is best preserved. As will be shown below, the same is true of *B. floweri* PALMER (1937).

In contrast to the sheath's surface with its various types of sculpture, the cross section of the sheath exposed at its broken apical end (Pl. 1, fig. 2M) exhibits only a very dense, regularly radially prismatic and at the same time concentrically lamellar structure indistinguishable from that of the Belemnitida (JELETZKY, 1966, p. 18). Furthermore, approximately the same Belemnitida-like structure predominates in the innermost part of the cross section of the broken part of the alveolar end of the sheath (Pl. 1, fig. 2K-L). Only the outer three-quarters to one-third of this cross section exhibits the sculpture consisting of white to dirty white, well-calcified bodies and interspaces filled out by darker-colored, presumably more imperfectly calcified to largely organic matter. It must be stressed, however, that only the outermost layer of this cross section includes numerous, mostly well-formed spheroidal, oolite-like bodies. Its subsequent sheath layers exhibit only a few irregularly shaped subspheroidal bodies which are, for the most part, ill-defined in their basal (i.e., inner) part. A number of these white-colored, well-calcified bodies are columnar to toothlike instead of subspheroidal. Some of them extend inward all the way to the sharply defined outer boundary of the regularly concentrically lamellar innermost sheath layer (Pl. 1, fig. 2K-L). Others disappear in an almost homogeneous to indistinctly concentrically lamellar, whitish gray, apparently uniformly calcified sheath matter before reaching the outer margin of the inner sheath layer. The interspaces filled out by the darker-colored matter are relatively rare in these intermediate layers. They invariably pinch out completely farther inward.

The described internal structure of the oral end of the *Belemnosella americana* sheath can be explained by assuming that the speed of its deposition increased only gradually after the initial phase of slow growth (reflected in the Belemnitida-like structure of its innermost part) was somewhat abruptly concluded. If one accepts this hypothesis, the shortage of calcium carbonate only became acute during the closing growth stage of this particular *B. americana* sheath. These relationships differ from those observed in the *Amerirostra americana* sheath.

It must be pointed out in this connection that the observed internal structure of the *Belemnosella americana* sheath could also be explained as the result of a post-mortem alteration (weathering) of an originally more or less homogeneous, Belemnitida-like structured sheath. The more nearly spheroidal, oolitelike bodies of the outermost preserved sheath layer would then represent less-altered remnants of the original strongly calcified sheath matter surrounded by much more strongly altered, largely decalcified matter. The less perfectly developed, commonly columnar to toothlike bodies of the immediately underlying sheath layers would reflect their correspondingly lesser alteration. The still deeper, more or less homogeneous or indistinctly concentrically laminated, evenly calcified layers in which these ill-formed, markedly stronger calcified bodies are rooted would represent an even less altered inner part of the sheath. The innermost, Belemnitida-like structured layer, finally, would exhibit the original, essentially unaltered appearance of the *B. americana* sheath. This hypothesis, however, is contradicted by the previously described presence in some specimens of the outermost much better

calcified sheath layer, by the remarkable regularity of the shape and distribution of the spheroidal, strongly calcified bodies in the immediately underlying sheath layer, and by the much more typical development of the same inner structure in *Amerirostra americana.* Therefore, I prefer to ascribe the spongy mixed organic-aragonitic structure of some parts of the Sepiida sheath to its unusually rapid growth (JELETZKY, 1966, p. 64, and the section of this paper dealing with internal structure of the *Amerirostra americana* sheath).

As in the case of *Amerirostra americana,* a definitive conclusion about the true nature of the sheath structure of *B. americana* was precluded by the unavailability of polished sections or thin sections of its sheath.

PHRAGMOCONE.—The break across the base of the apical spine of the *Belemnosella americana* sheath runs through its protoconch (Pl. 1, fig. 2H,M). The fairly large protoconch is longitudinally elongated and pear-shaped. It is markedly separated from the earliest camera by a deep constriction. On the whole, it is remarkably similar in its shape and proportions to the apparently larger, better-exposed protoconch of *Belemnosis cossmanni* reproduced in this paper (Pl. 1, fig. 1H,J).

The long axis of the protoconch is fairly strongly deflected adventrally and appears to form an angle of about 25 to 30 degrees with the longitudinal axis of the shell (and of the adoral parts of the phragmocone) instead of being directed more or less straight adapically as was previously thought (JELETZKY, 1966, p. 106).

Looking inside the phragmocone through the broken protoconch, it is possible to see that the first two or three camerae are also feebly incurved endogastrically.

So far as one can see, the dorsal wall of the earliest part of the phragmocone has about the same degree of convexity as the dorsal surface of the corresponding part of the sheath (Pl. 1, fig. 2B,E-F, Fig. 2). Only the subsequent part of the phragmocone is more or less orthoconic.

An abrupt decrease in endogastric curvature of the apical part of the phragmocone seems to occur at the junction of the protoconch and first camera, similar to that present in the figured specimen of *Belemnosis cossmanni* (Pl. 1, fig. 1H,J). It is impossible to assert the presence of this feature in *Belemnosella americana* without finding and sectioning additional specimens of the species. However, the reconstruction of the cross section of *B. americana* attempted in this paper (Fig. 2) assumes the presence of this feature.

It was impossible to measure the apical angle of the phragmocone in the only specimen available. The dorsoventral apical angle seems to be in the order of 12 to 16 degrees, however. The cross section of the phragmocone is noticeably depressed. It was impossible, however, to measure its depression ratio. The camerae are relatively low. Their height fluctuates approximately between 0.20 and 0.25 of their lateral diameters measured along the next adapical septa in the three complete adoralmost camerae visible in Pl. 1, fig. 2A,D.

The conotheca is preserved only in the earliest two camerae visible through the narrow, adoral part of the medioventral depression (Pl. 1, fig. 2A,D). So far as one can judge, it has the same thickness and general appearance as that of *Amerirostra americana.* The poorly preserved inner surface of the conotheca seems to be smooth in these two camerae. Farther adorally the inner surface of the sheath, which is clearly visible through the widened adoral part of the medioventral depression, bears a well-preserved imprint of the outer surface of the conotheca (Pl. 1, fig. 2A). Only its dorsal and lateral parts are clearly observable in this part of the alveolar cavity. So far as possible to see at magnifications of $\times 22$ to $\times 44$, the outer part of the conotheca is covered by closely and evenly spaced, very fine, transverse ridges and furrows, apparently representing growth lines. The ridges and furrows essentially parallel the suture lines all around the preserved circumference of the alveolus.

No traces of sublongitudinal asymptotic striae or sharp adapical bends of conothecal growth lines can be seen anywhere on the lateral surfaces of the alveolus, although the imprints of conothecal growth lines are generally well preserved throughout their extent. Therefore, and considering the circumstance that both lateral surfaces are completely visible in our specimen, the presence of a spatulate dorsal proostracum in *Belemnosella americana* is rather unlikely. Instead, the peristome of its phragmocone probably had the same appearance as that of the Recent *Spirula.* This interpretation is accepted as valid in the reconstruction of the *B. americana* shell attempted in

this paper (Fig. 2). Parts of the septa are only preserved bodily in the early section of the phragmocone adapically of the apical end of the medioventral depression. Therefore, it was impossible to study them in any detail. The same generally is true of the suture lines, except that the imprints of their exterior are observable on the dorsal and lateral sides of the alveolus through the widened adoral part of the medioventral depression. Judging by these imprints (Pl. 1, fig. 2A), the suture lines form very gently arched, broad dorsal saddles, which occupy all of the dorsum. Suggestion of a narrow, very shallow, but subtriangular, mid-dorsal lobe seems to appear in some of the best-preserved septal imprints, however. On the flanks the sutures are markedly oblique and slope down toward the venter. They seem to be essentially straight throughout the preserved larger parts of the flanks. The character of ventrolateral and ventral parts of the suture is uncertain. So far as seen, their course in the adapical part of the alveolus (Pl. 1, fig. 2J) appears to continue to slope down at the same rate through the greatest part of the venter. Then they seem to form a shallow but distinctly V-like ventral lobe restricted to the middle third of the venter.

The inner and outer surfaces of the conotheca contract markedly over the septa and expand in low outward convex arches between them, just as do the conothecae of *Spirula* and *Groenlandibelus* (JELETZKY, 1966, p. 98). These marked transverse corrugations of the conotheca are not reflected at all on the sheath's surface, except on that of the thin covering sheath layer of the medioventral depression. The outer surface of the latter, however, is much more faintly corrugated transversely as compared with its inner surface. This is caused by an appreciable increase in thickness of the covering sheath layer over the septa, clearly visible in its cross sections.

It was not possible to observe clearly any part of the siphuncle. One or two segments of it, however, may be preserved in the inaccessible early camerae where the corresponding parts of septa obviously are present, at least in part.

No imprints of septal lines were seen anywhere on the preserved surface of the alveolus.

BELEMNOSELLA FLOWERI (Palmer, 1937)

Plate 2, figures 2A-J

1937, *Advena floweri* PALMER, p. 512, pl. 76, fig. 10-12, 15.

1940, *Anevda floweri* PALMER, p. 285.

1941, *Belemnosella floweri* STENZEL, p. 90.—1965, PALMER & BRANN, p. 376-377.

1966, *Belemnosella americana* var. *floweri* JELETZKY, p. 106-107.

DIAGNOSIS.—*Belemnosella* form in which guardlike sheath is characterized by carinate appearance of adoralmost parts of its ventrolateral bulges, by transformation of adoralmost parts of its dorsolateral shoulders into adlaterally protruding dorsolateral bulges, and by marked V-like concavity of adoralmost parts of its flanks between their adlaterally protruding dorsolateral and ventrolateral parts; marked addorsal convergence of apical parts of flanks becomes reversed on adoralmost part of sheath, which is much more depressed than that of *B. americana,* and its strongly flattened dorsal side expands adorally at about 27 degrees; the rugose sculpture of the dorsum is considerably coarser than that of *Belemnosella americana*; regularly rounded (bosslike) ventral callus well defined, about equidimensional, and protruding adventrally much more strongly than in *B. americana*; ventral callus situated relatively closer to base of apical spine than in *B. americana*; feebly addorsally deflected, conical apical spine distinctly set off from main body of sheath.

MATERIAL AND TYPE SPECIMEN.—The only specimen of *Advena floweri,* described and figured by PALMER (1937, p. 512, pl. 76. fig. 10-12, 15) and preserved as no. 3402 in collections of the Paleontological Research Institution, Ithaca, New York, was originally designated as its holotype. It was studied by me but no additional specimens of *Belemnosella floweri* were available when this paper was written.

STRATIGRAPHICAL POSITION AND AGE.—According to PALMER & BRANN (1965, p. 376-377) the holotype of *Belemnosella floweri* is from the Gosport Sand (type), uppermost Claiborne Group, Claiborne Bluff, Alabama River (type), Monroe County, Alabama; it is dated as of middle Eocene age, but must be derived from younger beds than the holotype of *Belemnosella americana.*

Description

GUARDLIKE SHEATH.—The incomplete sheath of the holotype of *Belemnosella floweri* is 14.4 mm. long. Its about 6.4 mm. wide oral margin is believed to coincide approximately with the maximum lateral diameter of the sheath. Assuming its general shape and proportions to be more or less similar to those of *B. americana,* I

estimate the missing alveolar part of the sheath (Pl. 2, fig. 2A-G) to have been about one-quarter as long as its preserved section. If so, the restored total length of the holotype, including its largely preserved apical spine, would be between 17.5 and 18.0 mm. Judging by the inferred size of its holotype, *B. floweri* is a considerably smaller and sturdier species than *B. americana*. Its ratio of inferred total length to maximum lateral diameter is only $\simeq$ 2.8 (as compared with $\simeq$ 3.35 for the latter species).

In ventral aspect the preserved part of the holotype tapers gradually and more or less evenly from its broken oral end to a level slightly below the fissurelike apical end of the medioventral depression. This results in the approximately straight flanks of the specimen converging adapically at about 18 degrees throughout this interval (Pl. 2, fig. 2A,D). Farther adapically the flanks converge increasingly more rapidly toward base of the apical spine. This results in marked convexity of the flanks throughout this interval and in slightly mucronate appearance of the apical end of the sheath (Pl. 2, fig. 2A,D). This is in contrast with *B. americana* (Pl. 1, fig. 2A,D), the sheath of which tapers gradually and more or less evenly at 20 to 21 degrees all the way between the top of the slitlike part of the ventral depression and the broken base of the apical spine.

The feebly addorsally deflected, rapidly tapering, and correspondingly markedly subconical apical spine of the holotype is about 2 mm. long. Some, probably insignificant, part of its apical end is broken off. In ventral and dorsal aspects (Pl. 2, fig. 2A,C-D,G) the spine is only weakly set off from the rest of the sheath, the result of which is its mentioned feebly mucronate appearance. In lateral aspect (Pl. 2, fig. 2B,E-F) the more rapidly tapering spine is markedly separated from the broadly rounded base of the sheath's apex. This results in the markedly mucronate appearance of the sheath in this aspect. No exact comparison with the broken-off apical spine of *B. americana* is possible. The latter, however, was probably considerably smaller, less deflected addorsally, and less markedly set off from the main body of the sheath than the spine of *B. floweri*.

The ventral surface of the sheath is regularly and broadly rounded adapically of the medioventral depression when viewed ventrally (Pl. 2, fig. 2A,J). As it rapidly widens adorally from the base of the apical spine, the rounded ventral face of the sheath expands laterally and protrudes adventrally, forming a strongly elevated, well-defined, more or less regularly rounded and equidimensional mound—the ventral callus (JELETZKY, 1966, p. 62, 106).

The maximum adventral protrusion of the ventral callus in lateral aspect occurs about 3.7 mm. adorally of the broken apical end of the spine and only about 2.0 mm. adorally of the base of this spine. The sheath reaches its maximum dorsoventral thickness of 4.3 mm. at this level (Pl. 2, fig. 2B,E-F). The distance between the top of the ventral callus and base of the spine is relatively shorter than the corresponding distance in *Belemnosella americana,* the distance between the top of the ventral callus and base of spine comprising only $\simeq$ 0.11 of the inferred total length of the sheath (as against $\simeq$ 0.18 in the latter species). In lateral aspect the ventral callus of *B. floweri,* therefore, is considerably larger and more strongly swollen (i.e., protruding adventrally) than that of *B. americana* (Pl. 1, fig. 2B,E-F), especially if one takes into account the considerably smaller size of the former specimen. The ventral callus of *B. floweri,* furthermore, is differently shaped (more or less regularly rounded and bosslike) and much better defined than that of *B. americana.*

In lateral aspect the ventral surface of the sheath tapers both adorally and adapically from the level of its maximum dorsoventral diameter (Pl. 2, fig. 2B,E-F). As the ventral callus of *Belemnosella floweri* protrudes much more strongly adventrally and is situated considerably closer to the base of the apical spine than that of *B. americana,* its adapical tapering is considerably more rapid than that in the latter species. The ventral surface of *B. floweri* is markedly convex throughout the length of the adapical surface of the ventral callus (Pl. 2, fig. 2B,E-F), in contrast with the almost straight surface of the corresponding segment of the *B. americana* sheath (compare Pl. 1, fig. 2B, Pl. 2, fig. 2B).

Adorally of the maximum dorsoventral diameter of *Belemnosella floweri* (i.e., of the top of the ventral callus) the ventral surface of the sheath tapers gradually and more or less evenly all the way to its broken oral end, when viewed laterally (Pl. 2, fig. 2B,E-F). So far as preserved, this section of the sheath has the same appearance as that of *B. americana.*

Adorally of the ventral callus the preserved 9.5 mm. long section of the ventral side of the sheath is largely occupied by a more or less triangularly shaped, medioventral depressed area (=the ventral gash of JELETZKY, 1966, p. 106). In the adoralmost 1 mm. of this section the depression occupies all of the ventral side of the sheath and is not fringed by sublongitudinal bulges. However, the cross section of the broken-off covering sheath layer and conotheca exposed at its margins is already separated from the flanks of the sheath by deep, fissurelike, addorsally directed single furrows (Pl. 2, fig. 2A,J) throughout this interval. The flanking bulges of the medioventral depression begin adapically of this interval and rapidly widen within the next 3.5 mm. Unlike those of *Belemnosella americana,* the flanking bulges of *B. floweri* begin as low, ventrolaterally inclined carinae. These persist for 2 to 2.5 mm. adapically, gradually becoming higher, thicker, and blunter-edged in this direction (Pl. 2, fig. 2A,D,H,J). Then they become somewhat abruptly transformed into broadly rounded, low ventrolateral bulges. These sublongitudinal bulges are similar to those of *B. americana,* except for being somewhat more elevated and widening more rapidly on their inner sides. This results in their somewhat asymmetrical appearance in ventral aspect and in a relatively more rapid adapical narrowing and deepening of the enclosed part of the medioventral depression (compare Pl. 1, fig. 2A; Pl. 2, fig. 2A).

The ventrolateral bulges (including their carinalike parts) of *Belemnosella floweri* are more or less sharply separated from the only slightly concave, addorsally converging flanks of the sheath. Unlike the bulges of *B. americana* which merge imperceptibly into the flanks through rounded transition zones throughout the sheath's length (Pl. 1, fig. 2H-J), those of *B. floweri* meet the markedly concave flanks at an acute angle in the adoral third of the preserved part of its sheath (Pl. 2, fig. 2H,J), forming the low carinae described above. Farther adapically the boundaries become less sharp, forming narrowly rounded to almost angular shoulders. These finally disappear on the adoral flanks of the ventral callus approximately at the level of the apical end of the medioventral depression (Pl. 2, fig. 2I). The sublongitudinal bulges are sharply separated by deep fissurelike furrows from the thin covering layer of the medioventral depression throughout their preserved length. So far as one can see, the furrows do not differ materially from those of *B. americana.*

The medioventral depression becomes slitlike and deeply incised about 2 mm. adorally of the ventral callus and ends at its adoral margin without penetrating appreciably into its adoral part. The maximum depth of the slitlike part of the depression, the walls of which are more or less vertical in this interval, is estimated to reach about two-fifths of the maximum dorsoventral diameter of the sheath near its apical end (Pl. 2, fig. 2J). The preserved length of the medioventral depression is about 9.6 mm., while the length of the postdepression part of the sheath is about 5.0 mm.

So far as can be seen, the areal extent, structure, sculpture, and thickness of the covering layer of the medioventral depression of *Belemnosella floweri* do not differ materially from those of *B. americana.* This layer is only preserved within the slitlike part of the depression and locally farther adorally at its margins (Pl. 2, fig. 2A).

As visible in cross section of the broken oral end (Pl. 2, fig. 2J), the inner parts of the fissurelike single furrows flanking the medioventral depression are only about 0.8 mm. deep and are directed exactly addorsally. Their walls are in contact throughout this interval but diverge gradually in the outer (adventral) parts, which are approximately 1 mm. deep in the adoral half of the depression. As in *Belemnosella americana,* the furrows widen temporarily in the middle part of the depression only to narrow again farther adapically (Pl. 2, fig. 2A). Short, well-defined, round-topped ridges similar to those of *B. americana* occur within the widened parts of the furrows. These parts of the furrows merge imperceptibly into the flanking, carinalike parts of the ventrolateral bulges. Farther adapically the above ridges disappear as the furrows again narrow down to 0.2-0.3 mm. and their gaping outer parts deepen to some 1.5-2.0 mm.

The ventral surface of the sheath, including that of its ventrolateral bulges, is covered by minute, irregularly shaped granules, apparently arranged in subtransverse corrugated rows. The largest granules occur on the ventrolateral bulges where they may reach 0.25 mm. in diameter and be clearly visible to the naked eye (Pl. 2, fig. 2D). The surface of the ventral callus and that of the spine are much more finely granulated. The

granules are barely perceptible to the naked eye under favorable light conditions (Pl. 2, fig. 2D). However, their general appearance and arrangement in corrugated rows resulting in the shagreen-like appearance of the sheath's surface are clearly visible at magnifications of ×3 to ×5 (Pl. 2, fig. 2A). Even these finer granules of *Belemnosella floweri* are mostly somewhat larger than average granules of *B. americana* (compare Pl. 1, fig. 2A; Pl. 2, fig. 2A).

As in *Belemnosella americana* (Pl. 1, fig. 2A), a small area of the ventral surface surrounding the apical end of the medioventral depression is covered by much larger, irregularly rounded, closely spaced tubercles clearly visible to the naked eye (Pl. 2, fig. 2D). An ill-defined, round-topped medioventral ridge about 0.3 to 0.4 mm. wide and at least 1.8 mm. long extends across the anterior part of the ventral callus from the apical end of the medioventral depression, and disappears at its top. This feeble ridge (indistinctly visible in Pl. 2, figs. 2A,D) probably was about 3 mm. long originally and terminated on the adapical slope of the ventral callus, judging by its barely visible outline locally present within this interval. If so, this peculiar ridge was partly obliterated by weathering. However, it is possible that the ridge in its entirety is the result of differential weathering, just as appears to be the case with the above-described coarse granules around the slitlike apical ends of medioventral depressions of *B. floweri* and *B. americana* (see description of the latter species).

In lateral aspect the dorsal surface of *Belemnosella floweri* (Pl. 2, fig. 2B,E-F) is gently and about evenly convex everywhere between the base of the apical spine and broken oral end of the sheath. The dorsal surface of the apical spine is essentially straight and only slightly deflected addorsally. The uniformly convex outline of the dorsal surface of the *B. floweri* sheath contrasts with the predominantly more or less straight outline of that of *B. americana*. This convexity could possibly reflect a feeble endogastric curvature of most or all of the *B. floweri* phragmocone but this hypothesis could not be confirmed because of the impossibility of sectioning its only known specimen. The greater adventral protrusion of the ventral callus and the relatively shorter post-depression segment of the *B. floweri* sheath are suggestive of the relatively greater endogastric curvature of the apical part of its phragmocone as compared with that of *B. americana*.

The flanks of the sheath are oriented obliquely to the plane of its symmetry. Except in the adoralmost 6.5 to 7.0 mm. of their preserved parts, the flanks converge addorsally, forming angles of about 30 degrees with the symmetry plane (Pl. 2, fig. 2I), and are essentially similar to those of *Belemnosella americana* in this respect. Unlike *B. americana,* however, the flanks are almost or quite perpendicular closer to the oral end and then begin to converge adventrally in the adoral 2.0 to 2.5 mm. of the preserved part of the sheath. This reversal of direction of the flanks is caused by the following changes in the morphology of the flanks and dorsolateral shoulders of the sheath.

The addorsally converging flanks are straight to slightly convex within the interval about 2 mm. long between the base of the apical spine and top of the ventral callus (Pl. 2, fig. 2I). Ill-defined, very shallow longitudinal depressions 1 to 1.5 mm. wide appear between the narrowly rounded dorsal margins of the flanks (i.e., lateral margins of the flattened dorsal shield) and the feebly adlaterally protruding flanks of the ventral callus at the latter level. The slight depressions persist in this position throughout the adoral slopes of the ventral callus. Farther adorally they gradually widen to 2.0-2.5 mm. and turn slightly adventrally only to narrow gradually again to about 0.9 to 1.0 mm. at the broken oral end of the sheath. This adventral turn and a simultaneous adoral narrowing of the flanks results in a rapid adventral migration of the depressions, followed by their crossing of the ventral margins of the flanks.

Throughout the interval between the adoral end of the ventral callus and the broken oral end of the sheath the depressions gradually become deeper and more V-shaped until they become narrower again and cross the ventral margins of the flanks as about 1 mm. wide and equally deep, markedly V-shaped incisions at the oral ends of the carinalike parts of the ventrolateral bulges (i.e., at the broken oral end of the sheath (Pl. 2, fig. 2A-B,J). The lateral depressions become at the same time better and better delimited from the dorsal and ventral margins of the flanks because of their gradual respective transformation into the dorsolateral bulges and the ventrolateral carinae (Pl. 2, fig. 2A-B,J).

The described adoral changes in morphology of the flanks of the *Belemnosella floweri* sheath are diametrically opposed to those of the *B. americana* sheath. These changes result in a marginally double-bulged and medially deeply incised cross section of the flanks in proximity to the broken oral end of the *B. floweri* sheath (Pl. 2, fig. 2J), contrasting sharply with the simple, trapezoidal, subangular shape of the corresponding cross sections of *B. americana* (Pl. 1, fig. 2J). It seems likely that a similar shape of the flanks is retained throughout most or all of the missing adoral part of the *B. floweri* sheath.

The estimated (by projection of broken-off ventral wall of the sheath) dorsoventral diameter of the sheath reaches its apparent minimum value of 2.5 mm. at its broken adoral end where its apparent maximum lateral diameter of 6.4 mm. is also situated. Therefore, the adoral part of the *Belemnosella floweri* sheath has an estimated depression ratio of lateral diameter to dorsoventral diameter amounting to about 2.5. The *B. floweri* sheath, accordingly, is much more depressed in its alveolar part than that of *B. americana* (compare Pl. 1, fig. 2I-J, and Pl. 2, fig. 2H,J).

The depression ratio decreases rapidly in adapical direction from the broken oral end of the holotype until the sheath's cross section becomes approximately equidimensional (both diameters $\simeq$ 4.4 mm.) at the level about 4 mm. adoral of the apical end of the sheath. At this level the cross section of the sheath is markedly subtrapezoidal, with the maximum lateral diameter situated at its ventral margin.

The sheath cross section finally becomes weakly compressed at about the level of the maximum adventral protrusion of the ventral callus. At this level the dorsoventral diameter is about 4.3 mm. while the lateral diameter decreases to about 3.8 mm. This results in a compression ratio of lateral diameter to dorsoventral diameter of $\simeq$ 0.86, which is much smaller than that in the approximately corresponding cross section of *Belemnosella americana*. The same applies to the rest of the apical sections of these two species (compare Pl. 1, fig. 2H; Pl. 2, fig. 2I).

When viewed with the naked eye the flanks of *Belemnosella floweri* are sculptured largely in the same way as is its ventral surface. The same is true of their appearance at magnifications ranging from $\times$3 to $\times$15. A number of larger-sized, irregularly shaped mounds and pits are present locally, however, as for example on the right flank (Pl. 2, fig. 2B) near the oral end and at the level of the maximum adventral expansion of the ventral callus. These structures approach those of the dorsum in shape and size. Much less variety is seen in sculpture of the surface of the flanks of *B. floweri* than in that of *B. americana,* and it rarely exhibits well-defined tubercles or spheroidal, oolite-like bodies so commonly present on flanks of *B. americana*. These morphological differences, however, seem to be ascribable to the deeper weathering and alteration of the *B. floweri* sheath. The previously attempted interpretation of the sculpture of *B. americana* (see its description) is believed to be just as valid for that of *B. floweri.*

The dorsal sheath surface is narrowly but obtusely rounded in the apical 3 mm. It flattens rapidly and becomes only gently but regularly convex within the next 1 to 1.5 mm. as the dorsal sheath surface widens adorally (Pl. 2, fig. 2C,G). The dorsal sheath surface remains gently and regularly convex right to its broken oral end (Pl. 2, fig. 2H,J). Except for the oral 2.5 to 3 mm. where the rate of expansion decreases appreciably, the dorsal sheath surface widens at an angle of about 27 degrees. This apical angle is considerably greater than the only 19 to 20 degrees apical angles of *Belemnosella americana* and *B.* n. sp., Jeletzky, aff. *B. floweri.*

In the adapical half of the *Belemnosella floweri* sheath the subangular shoulders delimiting its flattened dorsal surface from the addorsally converging flanks are essentially similar to those of *B. americana*. Farther adorally, however, the dorsolateral shoulders of *B. floweri* are at first more angular than those of *B. americana* and then are transformed into rounded, increasingly strongly protruding dorsolateral bulges in the oral 2.5 to 3.0 mm. of the sheath. As has been pointed out, these bulges overhang the markedly concave V-like incised flanks and ventrolaterally protruding carinate parts of ventrolateral bulges within this interval (Pl. 2, fig. 2H,J) and presumably even farther adorally on the now missing part of the holotype of *B. floweri.*

All of the *Belemnosella floweri* dorsum is covered by an irregular coarsely rugose sculpture (Pl. 2, fig. 2C,G). This sculpture resembles somewhat that covering the dorsal shield of *Belosepia sepioidea* (Newton & Harris, 1894, pl. 10, fig. 1, 3), but differs in the irregularly vermiform to irregularly moundlike shape and

closer spacing of its individual elements, as well as in their much smaller size and height. The rugose sculpture of the dorsum of *B. floweri* has been compared with that of *B. americana* in describing the latter species. Like the considerably finer rugose sculpture of the dorsum of *B. americana,* the sculpture of *B. floweri* (Pl. 2, fig. 2C,G) does not exhibit any well-defined tubercles or spheroidal oolitelike bodies, presumably because of the profound weathering and alteration of the dorsal part of its sheath. The origin of this rugose sculpture appears therefore to be identical in the two species concerned.

The cross section of the broken alveolar end of *Belemnosella floweri* (Pl. 2, fig. 2J) exhibits the same spheroidal to irregularly shaped, or columnar, white-colored, and apparently well-calcified bodies as do the previously described cross sections of the oral parts of the *B. americana* sheath (compare Pl. 1, fig. 2K). Like the latter bodies, these structures of the *B. floweri* sheath are restricted to the outer three-quarters to one-third of the cross section and are underlain by the more or less regularly concentrically lamellar innermost sheath layer. The only apparent differences are in the relative dearth of darker-colored, presumably more imperfectly calcified interspaces in *B. floweri* and in the restriction of the more or less regularly spheroidal, white-colored bodies to the thinner, medial part of its dorsal sheath. The dorsolateral bulges of the shield consist exclusively of columnar to toothlike structures closely pressed to one another.

PHRAGMOCONE.—So far as one can see from the outside (Pl. 2, fig. 2A,D,H,J), shape and proportions of the phragmocone of *Belemnosella floweri* seem to be essentially similar to those of *B. americana,* except for its possibly somewhat stronger endogastrically incurved apical part (see previous section) and its apparently somewhat more depressed cross section. The presence of either of these morphological distinctions must remain in doubt, however, pending discovery of better-preserved specimens of *B. floweri.*

The inner surface of conotheca covers all exposed parts of the phragmocone (Pl. 2, fig. 2A). It is well preserved and bears closely spaced, very fine, transverse ridges and furrows. These apparent growth lines of the conotheca parallel the suture lines all around the preserved parts (dorsal and lateral) of the circumference of the alveolus and have exactly the same appearance as those of *Belemnosella americana.* It is concluded therefrom that *B. floweri* lacked a spatulate dorsal proostracum and resembled *B. americana* in possessing a *Spirula*-like peristome.

Neither the septa nor the siphuncle are observable inside earlier parts of the phragmocone. Judging by their imprints, the suture lines have exactly the same appearance as those of *Belemnosella americana.* The inner and outer surfaces of the conotheca are corrugated in the same manner as those of *B. americana* and other sufficiently well-known sepiids.

SIMILARITIES AND DIFFERENCES.—My conclusion (JELETZKY, 1966, p. 106-107) that *Belemnosella floweri* (PALMER, 1937) is only a morphological variant of *B. americana* must be revised in the light of my study of its holotype. In addition to such relatively insignificant distinctions as "greater enlargement of the ventral area just anterior to the spinose part of the sheath and . . . somewhat larger dimension of the spine" (JELETZKY, 1966, p. 107), the holotype of *B. floweri* differs from the holotype and only known representative of *B. americana* in a number of other, partly much more important morphological features. These important distinctions have been pointed out in describing *B. floweri* and briefly summarized in its diagnosis. The holotype of *B. floweri* was found in younger beds than that of *B. americana.* Accordingly no reason is seen to question the specific independence of *B. floweri,* in spite of the unavailability of additional material and the fragmentary nature of its holotype.

The morphological distinctions of *Belemnosella floweri* from *B.* n. sp., JELETZKY, aff. *B. floweri* are discussed in connection with description of the latter form.

BELEMNOSELLA n. sp., Jeletzky, aff. B. FLOWERI (Palmer, 1937)

Plate 2, figures 1A-I

DIAGNOSIS.—*Belemnosella* form differing from *B. floweri* in 1) rounded appearance of adoralmost preserved parts of ventrolateral bulges; 2) absence of adlaterally protruding dorsolateral bulges on adoralmost preserved part of sheath; 3) only slight concavity of adoral parts of flanks, which converge addorsally throughout preserved part of sheath; 4) considerably less depressed sheath cross section; 5) considerably greater slenderness of sheath, flattened dorsal side of

which expands adorally at 19 to 20 degrees; and 6) considerably larger and longer apical spine, which is strongly deflected addorsally; differing from *B. americana* markedly in the much coarser sculpture of its sheath and *B. floweri*-like appearance of its ventral callus and sheath outline.

MATERIAL.—One fragmentary specimen preserved as no. 10041 in collections of the Geology and Paleontology Department, Academy of Natural Sciences of Philadelphia.

STRATIGRAPHIC POSITION AND AGE.—According to its label, the above-mentioned specimen is from an unknown locality of the Claiborne Group in Alabama. Considering the sandy matrix attached to the sheath, it may possibly be from the Gosport Sand (type), uppermost Claiborne Group, Monroe County, Alabama. The specimen is of a general middle Eocene age.

Description

GUARDLIKE SHEATH.—The only known, incomplete sheath of this species is 12.7 mm. long; its broken oral margin is believed to be situated between 4 and 5 mm. adapically of the level of its maximum lateral diameter. Considering the much more slender proportions of this fossil, it is assumed that the missing alveolar part of its sheath was at least 8 to 9 mm. long. This would give it a total length of 21 to 22 mm. Its estimated length includes the apparently almost completely preserved 2.8 mm. long apical spine.

In ventral aspect, the preserved apical part of the sheath (Pl. 2, fig. 1A) only differs from the corresponding part of the *B. floweri* sheath (Pl. 2, fig. 2A) in its more slender, slightly more swollen ventral callus, and longer apical spine. The approximately straight parts of its flanks converge at about 16 degrees instead of 18 degrees for the corresponding parts of the *Belemnosella floweri* flanks.

In lateral aspect, the apical spine differs from that of *Belemnosella floweri* in being strongly deflected addorsally and in forming an angle of approximately 30 degrees with the longitudinal axis of the shell (Pl. 2, fig. 1B). Furthermore, it is considerably longer, larger, and more slowly contracting than that of *B. floweri* (Pl. 2, fig. 2B).

In lateral aspect, the ventral surface of the sheath tapers much more slowly adorally than that of the corresponding segment of *Belemnosella floweri* (compare Pl. 2, fig. 1B, 2B). This ventral surface is somewhat convex in contrast with the distinctly concave appearance of the ventral surface of the *B. floweri* sheath. This results in a much greater height of the adoral parts of flanks of *B.* n. sp., JELETZKY, aff. *B. floweri* as compared with that of *B. floweri* (Pl. 2, fig. 1B,E-F, 2B,E-F).

The ventral callus is generally similar to that of *Belemnosella floweri* in its shape, size, and position; nevertheless, it is somewhat longer and larger than the latter (compare Pl. 2, fig. 1A-B, 2A-B). The maximum dorsoventral diameter of 5.3 mm. coincides with the level of the top of the ventral callus. It is situated about 5.5 mm. adorally of the broken tip of the ventral spine and only about 3 mm. adorally of that spine's base. The adapical tapering of the lateral surface of the sheath from the level of the maximum dorsoventral diameter is about as rapid as that of *B. floweri*.

The preserved adapical part of the medioventral depression does not seem to differ materially from the corresponding part of that of *Belemnosella floweri* except in its somewhat greater length and depth, and in greater constriction of its slitlike apical part (Pl. 2, fig. 1A,D). The preserved parts of the ventrolateral bulges are broadly rounded throughout and do not exhibit any suggestion of becoming carinalike even in their adoralmost preserved parts. It is believed, therefore, that the now absent, more adoral parts of the ventrolateral bulges were similar to those of *B. americana* rather than to those of *B. floweri*.

So far as one can see, the structure, sculpture, and thickness of the covering sheath layer of the medioventral depression do not differ materially from those of *Belemnosella floweri*. The fine, closely spaced longitudinal ridges and furrows covering the surface of the depression appear to be higher and more sharply defined than those of *B. americana* and *B. floweri*, probably because of their better preservation.

As seen in the cross section of the broken adoral end (Pl. 2, fig. 1H), the inner parts of the fissurelike single furrows flanking the medioventral depression are directed dorsolaterally, forming angles of about 45 degrees with the dorsoventral plane of the sheath. This seems to contrast with the addorsal direction of these furrows in the oral cross section of *Belemnosella floweri*. However, this morphological difference may only be caused by the different positions of the cross sections concerned within the sheath. Farther adapically, the morphology of these furrows does not seem to differ materially from that of the *B. floweri* furrows.

The ventral side of the sheath, including that of the ventrolateral bulges, is covered by small granules arranged in subtransverse corrugated rows. However, these granules are mostly 1.5 to 2 times larger than those of *Belemnosella floweri* and are more or less regularly rounded to oval in cross section (compare Pl. 2, fig. 1A, 2A). As in *B. floweri,* the largest granules occur on the ventrolateral bulges where they may reach 0.75 mm. in diameter. Therefore the granules of *B.* n. sp., JELETZKY, aff. *B. floweri* as a rule are clearly discernible to the naked eye (Pl. 2, fig. 1D), whereas those of *B. floweri* are rather rarely and indistinctly visible (Pl. 2, fig. 2D). The granules of the small area surrounding the apical end of the medioventral depression, unlike those of *B. floweri,* either do not differ from granules covering other parts of the ventral surface or are only slightly larger. Like *B. americana,* our form does not seem to show any traces of the medioventral ridge occurring on the anterior part of the ventral callus of *B. floweri.*

In lateral aspect the dorsal surface of the sheath of *Belemnosella* n. sp., JELETZKY, aff. *B. floweri* is somewhat more markedly convex than that of *B. floweri* (Pl. 2, figs. 1B,E-F, 2B,E-F). The greater convexity of its adapical part is further stressed by pronounced addorsal deflection of the apical spine. The greater convexity of the dorsal surface of the sheath of the unnamed new species possibly could reflect the somewhat stronger endogastric curvature of part or all of its phragmocone as compared with that of *B. floweri.*

The flanks of the sheath are oriented obliquely to the dorsoventral plane of the sheath (i.e., its plane of symmetry). Addorsally they converge markedly throughout the preserved part of the sheath (Pl. 2, fig. 1H-I), and no indication of a reversal of their direction, such as occurs in the adoral part of the *B. floweri* sheath, seems to exist.

Barely perceptible, 1.5 to 2 mm. wide sublongitudinal depressions extend along the dorsal margins of the flanks between the dorsal base of the apical spine and the broken alveolar end. These depressions merge imperceptibly into the gently convex flanks of the ventral callus and subangular shoulders separating the flanks from the pronouncedly flattened dorsal surface of the sheath (Pl. 2, fig. 1H-I). If anything, these lateral depressions become weaker adorally, just as happens with essentially similar but more strongly developed lateral depressions of *Belemnosella americana.* The lateral depressions of *B.* n. sp., JELETZKY, aff. *B. floweri* are very unlike those of *B. floweri* and it appears quite unlikely that *B. floweri*-like depressions and sheath cross section could develop on its now missing oral part of the sheath.

The surface of the flanks is mostly sculptured in exactly the same way as the venter (Pl. 2, fig. 1B,E-F). However, considerable areas of the dense outermost sheath layer occur in proximity to the apical spine and within the above-described lateral depressions. No traces of fine transversely corrugated granulation, such as covers the surface of this layer in *Belemnosella americana,* have been observed on its surface in the new species, however, possibly because of poor preservation. The larger, more or less regularly rounded tubercles (actually spheroidal, oolitelike bodies) and darker-colored interspaces are locally visible through the semitransparent outermost layer just as in *B. americana.*

The mentioned morphological differences in sculpture of the flanks of the new species as compared with that of *Belemnosella americana* and *B. floweri* well may be due only to less satisfactory preservation.

The dorsal sheath surface is markedly convex and more narrowly rounded than that of *Belemnosella floweri* in its apical half. Farther adorally it remains more convex than that of *B. floweri* until the level of some 3 mm. adapically of its broken oral end. Within the latter interval the dorsal sheath surface becomes almost completely flat and somewhat less convex than the corresponding segment of *B. floweri* dorsum and remains like that right to its broken oral end. Throughout its preserved extent the dorsal sheath surface retains its much narrower appearance and smaller adoral expansion ratio (apical angle of 19 to 20 degrees) as compared with *B. floweri* (Pl. 2, fig. 1C,G, 2C,G). In these respects the dorsal surface of *B.* n. sp., JELETZKY, aff. *B. floweri* resembles closely that of *B. americana* (compare Pl. 1, fig. 2C,G).

The subangular shoulders separating the flattened dorsal surface of the new species from its addorsally converging flanks remain essentially similar to those of *Belemnosella americana* throughout the preserved part of the sheath (Pl. 1, fig. 2H-I; Pl. 2, fig. 2H-I). As with the sheath flanks, no reason is seen to think that these

shoulders become *B. floweri*-like on the now missing adoral part of the sheath.

The cross section of the broken adoral end of the sheath is relatively much more compressed than that of *Belemnosella floweri* (Pl. 2, fig. 1H, 2H), and has a subrectangular, somewhat trapezoidal shape with the maximum lateral diameter situated at its ventral margin. This cross section differs sharply from the previously described marginally double-bulged and medially deeply incised cross section of the broken adoral end of the *B. floweri* sheath (compare Pl. 2, fig. 1H, 2H,J). At the same time this cross section is essentially similar to that of the oral end of *B. americana* (Pl. 1, fig. 2I-J). Although the sharp morphological differences in the above cross sections could have been influenced strongly by their different positions within the sheaths concerned, it is reasonable to assume that the cross section of *B.* n. sp., JELETZKY, aff. *B. floweri* remained similar to that of *B. americana* throughout the alveolar part of its sheath.

By projecting the broken ventral wall of the sheath, the estimated dorsoventral diameter at the alveolar end of the new species is about 3.5 mm. as compared with the maximum (i.e., adventral) lateral diameter of 5.6 mm. This provides an estimated depression ratio of lateral diameter to dorsoventral diameter of $\simeq$ 1.6. In spite of its considerably more adapical position within the sheath, this cross section of the new species, therefore, is much less depressed than the oral cross section of *B. floweri.*

The depression ratio decreases very rapidly from the broken oral end of the sheath of *B.* n. sp., JELETZKY, aff. *B. floweri* and the cross section becomes about equidimensional only 3.0 to 3.5 mm. adapically from it. Farther adapically the sheath cross section rapidly becomes more compressed. At the level of the top of the ventral callus its maximum dorsoventral diameter is 5.2 mm., while the lateral diameter at the same level is only 4.0 mm. This signifies that the corresponding compression (compression ratio, lateral diameter to dorsoventral diameter =0.77) is considerably greater than that of *B. floweri* (compression ratio =0.86). The same is true of the more adapical parts of the sheath of the new species (compare Pl. 2, fig. 1I, 2I).

The sculpture of the preserved part of the dorsum of the unnamed species does not seem to differ materially from that of the corresponding part of the *Belemnosella floweri* dorsum (compare Pl. 2, fig. 1C,G, 2C,G).

The cross section of the broken alveolar end of the new species of *Belemnosella,* unlike that of *B. floweri,* only exhibits the variously shaped, white-colored, well-calcified bodies previously described in *B. americana* and *B. floweri* and intervening darker-colored, more imperfectly calcified interspaces within the rounded ventrolateral bulges (Pl. 2, fig. 1H). The rest of the cross section consists entirely of more or less regularly concentrical lamellar and at the same time dense radially prismatic, uniformly well-calcified matter identical with that of the innermost layer of adoral cross sections of *B. americana* and *B. floweri.* The structurally distinct parts of the cross section of the new species are sharply delimited from each other. It seems likely that these morphological distinctions are related to the considerably more adapical position of the cross section within the sheath as compared with those of *B. floweri* and *B. americana.*

SIMILARITIES AND DIFFERENCES.—The numerous morphological differences between *Belemnosella* n. sp., JELETZKY, aff. *B. floweri* and *B. floweri* and *B. americana* have been pointed out in description of the new species and briefly summarized in its diagnosis. They are mostly important taxonomically and strongly suggest that the unnamed form is distinct from both of the other mentioned species. I have refrained from naming the new species formally because of the fragmentary nature of the only known specimen and lack of available data as to its exact locality and age.

Family SPIRULIROSTRIDAE Naef, 1921

[=Spirulirostrinidae NAEF, 1921 (subj.)]

TYPE GENUS.—*Spirulirostra* D'ORBIGNY, 1841.

DIAGNOSIS.—Sepiida with apical part of otherwise Belemnoseidae-like phragmocone considerably more strongly incurved endogastrically, forming one half to one complete turn; medioventral depression (=mid-ventral gash) resembling that of belemnoseids but not becoming slitlike adapically, this depression either ending in pitlike excavation confined between ventral callus (=capitulum), transversely directed adapical ends of ventrolateral flanges, and phragmocone-bearing main part of sheath, or surrounding ventral callus and merging gradually into supplementary pos-

terior callus of sheath; true ventral callus more or less regularly rounded and much more strongly elevated than in Belemnoseidae and may be ornamented by spines; surface of ventral callus regularly convex, without Belemnoseidae-like furrows or depressions; additional variously shaped medioventral swellings of sheath may occur adapically of true ventral callus at apical end of medioventral depression, which is flanked by feebly to well-developed, salient, marginally sharpened ventrolateral flanges of sheath.

STRATIGRAPHICAL RANGE.—Oligocene to Miocene.

GEOGRAPHICAL DISTRIBUTION.—Western and southern Europe (West Germany, northern Italy, Sardinia), Central America (southern Mexico), Australia.

Discussion

The family Spirulirostridae was proposed by NAEF (1921, p. 536) for *Spirulirostra* D'ORBIGNY (1842) and *Helicerus* DANA (1848). NAEF (1922, p. 61, fig. 21) later described a new genus, *Spirulirostridium,* and included it in the Spirulirostridae.

The family Spirulirostrinidae NAEF (1921, p. 536), based on some Miocene *Spirulirostra*-like specimens identified by NAEF (1922, p. 75-76, fig. 29) as *Spirulirostrina lovisatoi* CANAVARI (1892) appears too closely similar to Spirulirostridae to warrant distinction as a separate family, or even subfamily. Morphological similarity of these fossils to Sepiidae and Belosepiidae, which prompted NAEF (1922, p. 75) to separate them from Spirulirostridae, appears to be only superficial and to represent homeomorphy. The Spirulirostrinidae accordingly are placed in synonymy with the Spirulirostridae.

The morphological similarities and differences between Spirulirostridae and Belemnoseidae and the inferred phylogenetical relationships between these two families have been discussed in describing the latter.

NAEF's (1922, p. 60-61, 67, fig. 101) idea on close affinity of Spirulirostridae with Sepiidae (including Belosepiidae) and his derivation of both sepiids and spirulirostrids from a *Spirulirostra*-like root-stock appear to be erroneous. The true Sepiidae (exclusive of Belosepiidae) are now known (LÖRENTHEY, 1898; SZÖRENYI, 1933; WAGNER, 1938) to occur in middle to upper Eocene of Hungary, and peculiar belosepiid-like forms (*Pseudosepia vera* DESHAYES) transitional between Sepiidae and Belosepiidae exist in middle Eocene beds of Paris Basin. Furthermore, NAEF's (1922, p. 60-61, 67-68) conclusions as to the Eocene age of *Spirulirostra curta* TATE are erroneous. According to BERRY (1922, p. 330), this Australian *Spirulirostra* was found in Miocene rocks. Finally, as pointed out in the Belemnoseidae section, the oldest known Spirulirostridae (e.g., *Belopteridium obtusum* from the lower Oligocene of Tyrol) are closely allied to the middle Eocene (Lutetian) *Belemnosis* and have apparently evolved either from this genus or from some still unknown *Belemnosis*-like representatives of the Belemnoseidae.

The morphological distinctions of all known representatives of the Spirulirostridae from Belosepiidae are even more far-reaching. The only sufficiently well known representative of the Belosepiidae (*Belosepia* VOLTZ, 1830) only resembles spirulirostrids in possessing a characteristic medioventral depressed area (=mid-oral gash of JELETZKY, 1966, p. 106) on the alveolar part of the sheath. The medioventral depression of *Belosepia* differs sharply from that of Spirulirostridae, however, in the following morphological details (1-5).

1) Absence of adapical narrowing and broadly rounded shape of the apical margin.

2) Completely flat appearance of the surface of the conotheca and overlying thin sheath cover within the limits of the depression. This flattening of the *Belosepia* phragmocone results in its markedly hooflike cross section, in which the ventral wall runs about normal to the flat and subparallel flanks. This ventrally flattened phragmocone cross section contrasts sharply with those of the more or less markedly depressed but nevertheless regularly rounded phragmocones of all known representatives of the Spirulirostridae.

3) Strong shortening of the flattened ventral wall of the conotheca and that of the overlying sheath cover within the medioventral depression. These walls appear to be restricted to the adapical quarters of the lateral and dorsal walls of the conotheca and sheath in the best-preserved specimens of *Belosepia* studied. Among Spirulirostridae, in contrast, the more or less regularly convex ventral walls of the conotheca and sheath are about as long as their dorsal and lateral walls.

4) Complete absence of sublongitudinal furrows at lateral margins of the medioventral depression.

5) Presence of a rufflike, adapically recurved ventral plate surrounding lateral and adapical

margins of the flat-bottomed medioventral depression. Although somewhat similar to the salient, ventrolateral sheath flanges of Spirulirostridae, this ventral plate of *Belosepia* is probably only a homeomorphic structure, as it is not separated from the medioventral depression by sublongitudinal furrows (see 4).

Additional distinguishing features of *Belosepia* are the following (6-8).

6) Presence of a large, shallow, cuplike protoconch which is separated from the first camera indistinctly by a shallowly incised constriction. This primitive protoconch contrasts sharply with the much more advanced protoconch of all better-known representatives of the Spirulirostridae (e.g., *Belopteridium, Spirulirostra, Amerirostra*). The latter is comparatively small, spherical to elliptical, and separated from the first camera by a pronounced constriction.

7) Strongly compressed and more or less rectangular cross section of the *Belosepia* phragmocone and sheath, which contrasts strongly with the depressed but regularly rounded cross section of the spirulirostrid phragmocone and sheath.

8) Important morphological distinctions in structure of the *Belosepia* siphuncle and septa discussed by NAEF (1922, p. 81-83, fig. 33).

These morphological distinctions and the considerably older age of all known representatives of the Belosepiidae (late Paleocene-late Eocene) are obviously incompatible with derivation of this family from *Spirulirostra*-like ancestors, as postulated by NAEF (1922, p. 60-61, 67-68). Furthermore, *Belosepia* is a distinctly more primitive form (e.g., in morphology of its protoconch) than any known representative of the Spirulirostridae (or for that matter of the ancestral Belemnoseidae). This suggests separation of Belosepiidae from the hypothetical sepiid root-stock prior to the branching apart of the Belemnoseidae-Spirulirostridae lineage. As pointed out in discussing the Belemnoseidae, the same appears to be true of the Belopteridae. The latter differ from the Spirulirostridae in most morphological features that distinguish them from the Belemnoseidae. However, the latest known representative of the Belopteridae *(Beloptera)* superficially resembles all known genera of the Spirulirostridae in presence of well-developed, salient, ventrolateral outgrowths of the sheath. This similarity is purely homeomorphic in nature.

Genus AMERIROSTRA Jeletzky, n. gen.

TYPE SPECIES.—*Spirulirostra americana* BERRY, 1922; by monotypy.

DIAGNOSIS.—Phragmocone forming complete turn so that protoconch almost touches ventral wall of conotheca; ventral side of sheath ornamented by 2 bosslike mid-ventral calluses (=capitula), smaller adoral one occurring inside medioventral depression and harboring coiled part of phragmocone, and larger adapical callus occurring at apical end of medioventral depression.

STRATIGRAPHIC RANGE.—Miocene.

GEOGRAPHICAL DISTRIBUTION.—Mexico (Vera Cruz - Santa Rosa - Isthmus of Tehuantepec).

Discussion

Amerirostra JELETZKY, n. gen., as characterized by its only known species, *A. americana* (BERRY, 1922), differs from all hitherto described European and Australian species of Spirulirostridae in the following features:

1) The adapical part of its phragmocone forms a complete turn with the protoconch virtually in contact with the ventral wall of the phragmocone and embedded in the thin calcareous ventral wall of the guardlike sheath at top of the feebly developed adoral ventral callus (=capitulum).

2) The guardlike sheath forms a second, larger, bosslike ventral callus about 0.4 of the distance adapically from that harboring the coiled apicalmost part of the phragmocone.

3) The adoral ventral callus, homologous to the only ventral callus of *Spirulirostra,* situated within a shallow medioventral depression (=ventral gash) of the sheath situated between its lateral flanges, rather than at the adapical end of this depression. It does not protrude above the plane formed by the lateral flanges of the sheath of *Amerirostra* as does the only ventral callus of *Spirulirostra.*

Amerirostra also differs from *Spirulirostra* in length and shape of its dorsal shield. In dorsal aspect, the shield of both better-known species of *Spirulirostra (see S. hoernesi,* KOENEN, 1867, pl. 14, fig. 6; NAEF, 1922, fig. 23a-c, and *S. bellardi sepioidea* NAEF, 1922; MICHELOTTI, 1847, pl. 15, fig. 2) has a more or less regularly spindlelike shape. It tapers about equally slowly and more or less evenly adorally and adapically from the level of the 15th or 16th camera where it reaches

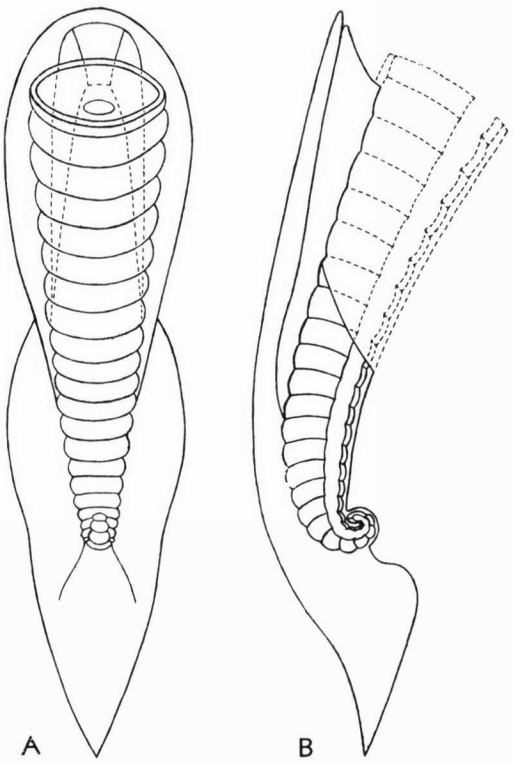


FIG. 3. Diagrammatic reconstruction of complete shell of *Amerirostra americana* (BERRY, 1922), ×4, without attempt to reproduce exactly structural details of septa and siphuncle.——3,*A*. Ventral view (ventral part of sheath removed to simplify scheme of phragmocone and adorsal part of sheath).——3,*B*. Lateral view (sectional except for dorsal shield and buttress).

its maximum width. So far as known, the adoral tip of the shield of *Spirulirostra* is more or less spinose and similar to its apical end. The dorsal shield of *A. americana* has a featherlike shape and continues to expand almost to its adoral end when viewed from the dorsal side. Furthermore, its adoral end is not sharpened but broadly rounded (Fig. 3,*A*).

Judging from figures given by MICHELOTTI (1847, pl. 15, fig. 2), *Spirulirostra bellardi sepioidea* NAEF (1922) seems to lack the medioventral buttress which separates the adoral part of the dorsal shield of *Amerirostra* from the corresponding part of its phragmocone. Instead, the lateral parts of its dorsal shield seem to envelop the dorsal part of the phragmocone, at least in its adapical part. It was not possible, however, to confirm these structural relationships in any of the actual specimens of *Spirulirostra* studied, as these invariably lacked the adoral half of the dorsal shield and corresponding parts of the phragmocone. This apparently important morphological distinction is omitted from the diagnosis of *Amerirostra*.

The above-mentioned morphological distinctions appear to be ample to separate *Spirulirostra americana* generically from the European and Australian species of the genus.

Amerirostra appears to be an independent offshoot from *Spirulirostridium* or from some other unknown spirulirostrid ancestor similar to it (Fig. 1). The tendency among some European spirulirostrids (e.g., *Spirulirostra bellardi sepioidea* NAEF, 1922, p. 67, fig. 24B, and *Spirulirostrina lovisatoi* CANAVARI, 1892; *see* NAEF, 1922, p. 75-76, fig. 24b-d) to develop second mid-ventral calluses adapically of the medioventral depression is believed to be a homeomorphic development in view of the fact that these forms are otherwise morphologically unlike *Amerirostra*.

In the present state of knowledge *Amerirostra* is restricted to the Western Hemisphere.

AMERIROSTRA AMERICANA (Berry, 1922), Jeletzky, n. comb.

Figures 3-5; Plate 2, figures 3-5; Plate 3, figures 1-2

TYPE SPECIMEN.—The fragmentary specimens figured by BERRY (1922, fig. 1-3) and used by him for the purpose of restoring a complete shell of *Spirulirostra americana* (BERRY, 1922, fig. 4-5) are syntypes of the species, as there is no proof that they represent apical and oral parts of one and the same specimen respectively. The fragmentary apical part of the shell figured by BERRY (loc. cit.), and reproduced in this paper accordingly, is selected herewith as the lectotype of *Amerirostra americana* (BERRY, 1922). The lectotype is preserved in USNM collections, Washington, D.C., as no. 644841a.

DIAGNOSIS.—Same as for genus.

MATERIAL.—I have investigated 3 fragmentary specimens of the apical part of the shell (including the lectotype) and 1 fragment of the oral part of the sheath (USNM no. 644841b). All of these specimens are labeled as coming from the type locality of the species. They are preserved in USNM collections in Washington, D.C.

STRATIGRAPHIC RANGE.—Same as for genus.

GEOGRAPHICAL DISTRIBUTION.—Same as for genus.

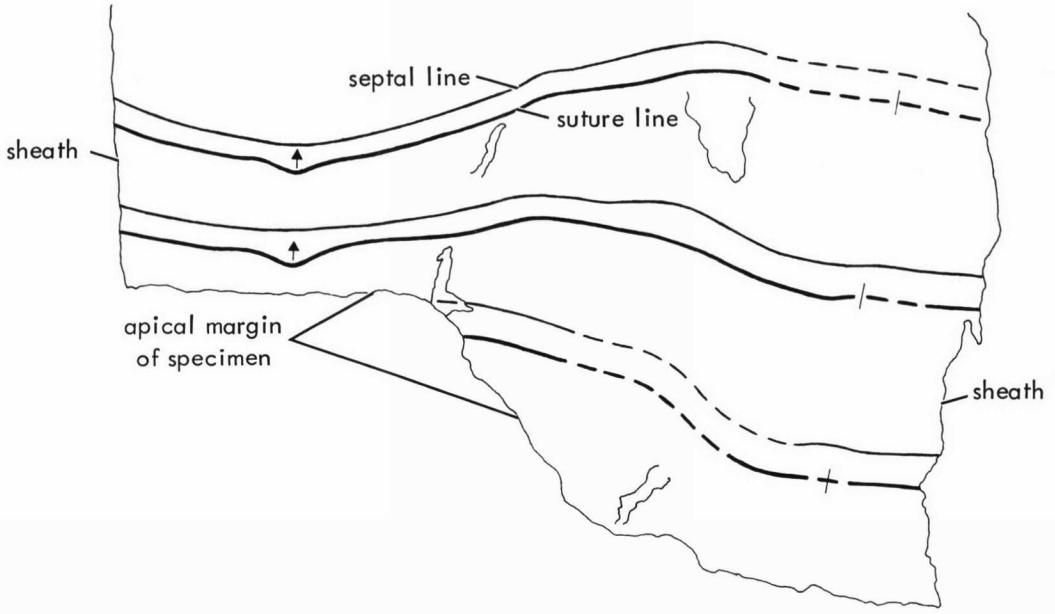


FIG. 4. *Amerirostra americana* (BERRY, 1922). Camera lucida drawing of three adapical suture and septal lines of the phragmocone fragment shown in Pl. 3, fig. 1A-D, ×25. [See text for further explanation.]

Description

GUARDLIKE SHEATH.—The apicalmost part of the guardlike sheath is shaped like a strongly compressed, dorsally deflected spike gradually tapering to a point in dorsoventral and lateral aspects. The tip is broken off in the lectotype (Pl. 2, fig. 3A-G) and in one of the topotypes. It is completely preserved in the larger topotype (Pl. 2, fig. 4A-H), however. In this specimen the tip is not set off from the main body of the spike. In cross section (viewed from the apical end; Pl. 2,

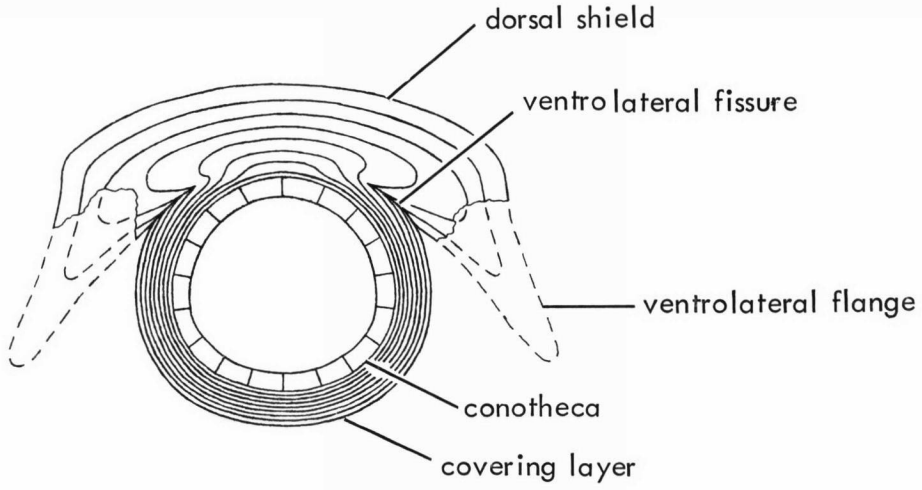


FIG. 5. Diagrammatic reconstruction of adoralmost cross section of lectotype of *Amerirostra americana* (BERRY, 1922) shown in Pl. 2, fig. 3I, approx. ×6. [The broken off parts of ventrolateral flanges are shown in dashed lines. See text for further explanation.]

fig. 4H) the spike has a markedly trapezoidal shape with a narrowly rounded dorsal side, obliquely slanted flanks, and a wider, more broadly rounded ventral side. The maximum lateral diameter is situated near the ventral side. In dorsoventral aspect the more or less evenly converging sides of the spike are essentially straight. In lateral aspect, however, its ventral side is slightly (Pl. 2, fig. 3B,E-F) to distinctly (Pl. 2, fig. 4B,E-F) convex while the dorsal side is distinctly (Pl. 2, fig. 4B,E-F) to markedly (Pl. 2, fig. 3B,E-F) concave. In the better-preserved, larger topotype (Pl. 2, fig. 4C,G), the tip of the spike carries a well-defined but short, dorsal, longitudinal furrow, which may possibly have been caused by post-mortem abrasion, at least in part. Less distinct single apical furrows of about the same length and orientation occur in the middle of both flanks of the tip. A few similarly long and longitudinally oriented striae occur between these 3 furrows (Pl. 2, fig. 4B). Otherwise, the surface of the spike mostly appears to the naked eye to be more or less finely and irregularly granulated. Some other areas appear to be virtually smooth. The granules and irregular mounds are separated by subtransverse vascular impressions and more or less deep, vermiform furrows. Under a magnifying glass the more or less indistinct small granules and furrows are visible over most of the apparently smooth areas. Wherever the surface of the spike is especially strongly worn (as for example on the ventral side of the larger topotype; Pl. 2, fig. 4A), the abrasion and deepened vermiform furrows surrounding the apparent granules in combination with their worn-down state reveal their globular shape and oolitelike, concentrically layered internal structure (*see* section on internal sheath structure).

As it gradually widens adorally, the broadly rounded ventral face of the spike develops into a more or less bosslike apical callus. In the lectotype (Pl. 2, fig. 3) this boss has an approximately semiglobular shape. In the larger topotype, however, it is much less protruding, but larger, and has an oval, longitudinally elongated shape (Pl. 2, fig. 4). The apical callus of the smaller topotype is transitional in appearance between these two extremes. The surface of this posterior larger callus is prominently and coarsely granulated throughout.

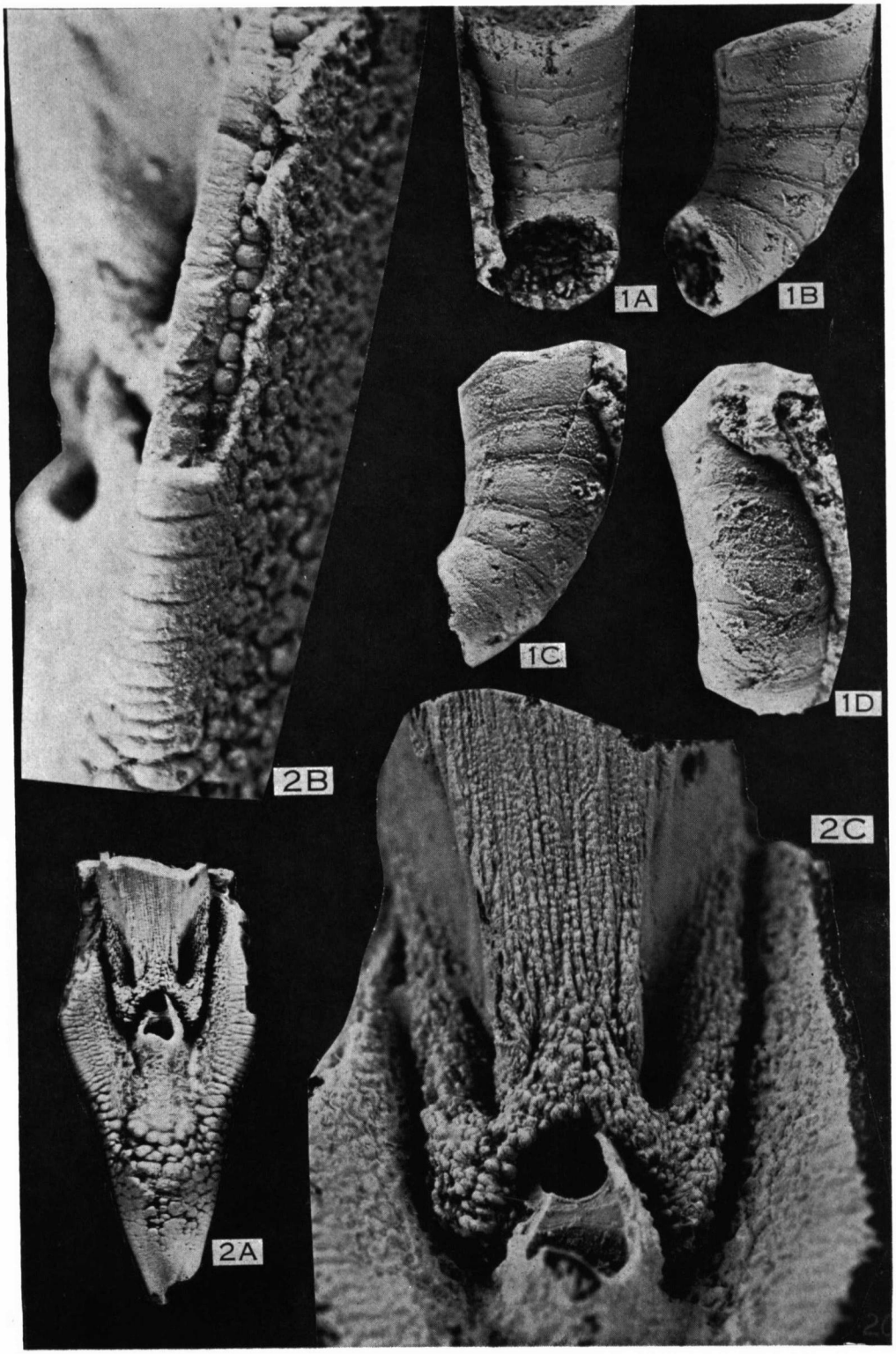
Adorally from the larger apical callus, the ventral surface of the postalveolar part of the sheath becomes more and more strongly depressed as the sheath begins to widen laterally on either side into winglike flanges. This ventrally depressed part of the sheath cannot be considered as part of the spike (=rostrum) proper. It differs, however, from the morphologically similar parts of the sheath of other genera of the Spirulirostridae in beginning well adapical of the phragmocone's tip. This results in the postalveolar part of the sheath of *Amerirostra* being relatively (to the complete shell) considerably longer and more massive than that of any other spirulirostrid form known.

In all 3 specimens studied, the large ventral depressed area of the sheath extends to the broken-off alveolar end. Throughout its preserved length this area is flanked by fairly narrow, winglike flanges directed ventrolaterally. These always incompletely preserved flanges are thickest at their bases, where they merge into the dorsal shield proper. From their bases the flanges gradually and evenly thin out toward their margins, resulting in their more or less regularly triangular cross sections. The flanges begin in the oral corners of

EXPLANATION OF PLATE 3

FIGURE

1. *Amerirostra americana* (BERRY, 1922), phragmocone of specimen shown in Pl. 2, fig. 4 (×10) showing fine details of its suture lines, septal lines, and conothecal growth lines (see text and Fig. 4 for details). ——A. Ventral view.——B. Ventrolateral view.——C. Dorsolateral view.——D. Dorsal view.
2. *Amerirostra americana* (BERRY, 1922), same specimen as shown in Pl. 2, fig. 3.——A. Ventral view (×3). ——B. Lateral view (×10) of cross section of right flange shown natural size in Pl. 2, fig. 3E; layer of spheroidal, oolitelike, strongly calcified bodies separated by furrowlike cavities apparently originally filled by less calcified or predominantly conchiolinic? substance clearly discernible inside of break (see text for details).——C. Ventral view of medioventral depression and strongly damaged adoral (true) ventral callus (×10); cross section of protoconch, imprints of ventral parts of two earliest septa, and those of corresponding segments of siphuncle clearly visible inside broken ventral callus.


1A
1B
1C
1D
2A
2B
2C

the previously described apical larger callus which forms the adapical margin of the ventral depressed area. From this point they gradually widen orally to about the level of the initial coiled part of the phragmocone, which occurs at about the middle of the preserved part of the depressed ventral area of the sheath in all three specimens studied. Farther orally the flanges contract equally gradually throughout the remainders of the alveolar parts of all 3 shells studied (Pl. 2, fig. 3A,D, 4A,C-D, 4G). The adoral ends of the flanges are not preserved in any of the specimens studied. It seems likely, however, that they merge gradually into the upper flanks of the dorsal shield somewhere within its missing part, between the oral end of the lectotype and the apical end of the only specimen of the oral part of the sheath available (Pl. 2, fig. 3A, 5A; Text fig. 3,*A*). At least, no traces of these flanges were seen on the apical end of the shield of the last mentioned specimen.

The ventral depressed area of the lectotype of *Amerirostra americana* is covered by the layer of calcareous guardlike sheath throughout its preserved part. Only insignificant remnants of this layer are now preserved in both topotypes studied. It seems likely, however, that this sheath layer had completely covered the surface of their conotheca as well. Its thickness is rather variable but, as a rule, it is much thinner than the sheath layer of the winglike ventrolateral flanges or that of the dorsal shield. It is about 0.5 mm. thick at the broken-off oral end of the lectotype where the underlying conotheca is about 0.25 mm. thick. The surface of the sheath layer within the ventral excavated surface is rather complexly sculptured. A broad and rounded, fairly pronounced, longitudinal ridge extends all the way between the larger adapical callus and smaller, apparently bosslike, but invariably incompletely preserved (Pl. 2, fig. 3A; Pl. 3, fig. 2A), anterior true callus harboring the coiled initial part of the phragmocone. This ridge is flanked by two equally broad and prominent longitudinal depressions merging imperceptibly into sides of the ridge and into inner margins of the adapical parts of the flanges. The surface of these structures is either irregularly corrugated or covered by irregular granules and vermiform furrows.

Adorally of the anterior true callus harboring the coiled initial part of the phragmocone begins a broad elevation of the median zone of the sheath layer of the ventral depressed area. This longitudinally oriented zone is flat-topped and widens gradually adorally; it is boxlike in cross section, protrudes strongly above the rest of the ventral excavated area, and is sharply delimited from the latter. Its steeply sloping flanks are ornamented by several narrowly rounded, fairly heavy ridges and intervening, equally narrow furrows which form angles from 30 to 50 degrees with the longitudinal axis of the shell (Pl. 2, fig. 3B).

The flat top of the elevated median zone appears to an unaided eye to be covered by a number of very fine, indistinct longitudinal striae (Pl. 2, fig. 3A,D). When seen at magnifications of $\times 10$ to $\times 12$ (Pl. 3, fig. 2A,C), however, these striae are resolved into some 20 to 30 fine, high, abruptly flanked, strongly reticulate, more or less irregularly wavering and locally ramifying, longitudinal ridges separated by similarly deep and narrow grooves. The reticulated appearance of the ridges is caused by their being built of strings of fine to very fine oolitelike bodies, (see section on sheath structure) some of which protrude above the dense, glazed surface of the zone in the shape of granules. Because of the semitransparent nature of the outer layers of these ridges, the embedded parts of the oolitelike bodies and other similar but completely enveloped bodies are clearly visible in places.

The ridges and grooves become increasingly fine and more irregularly shaped adorally. Also their number increases by intercalation and ramification as the ridges become lower and the grooves shallower. Finally, the surface of the flattopped median zone retains only a suggestion of very fine ridges and furrows, acquiring an irregularly shagreenlike (i.e., very finely granulated) appearance near its broken-off oral end. The inner structure also becomes much finer, but otherwise remains the same.

Adapically the ridges gradually become coarser with accompanying decrease in number. Finally, they disappear into a maze of somewhat elongated, irregularly oriented tubercles and vermiform grooves about 5 to 7 mm. adorally of the protoconch. As mentioned in the section on internal sheath structure, these tubercles and grooves are only the rugged, deeply corroded surface of a thick layer built of the agglomeration of small, tightly packed, more or less irregularly rounded, oolitelike bodies enclosed in an apparently less

thoroughly calcified, irregularly granulated to spongy matrix. All the remaining adapical part of the zone, as well as two obliquely directed, rounded ridges branching off from its apical end, possesses this structure. No dense, mostly glazed, covering layer, such as occurs farther adorally, is apparent here.

The elevated central zone of the ventral depressed area gradually becomes less well delimited adorally, acquiring a more or less regularly rounded surface at the broken oral end of the lectotype (Pl. 2, fig. 3I). At its apical end the zone splits into two obliquely directed, rounded ridges which circle the oral half of the previously described anterior true callus (Pl. 3, fig. 2A,C). Approximately midway on the flanks of this true callus both ridges disappear underneath it, merging into the oolitelike-textured mass which fills the umbilical perforation of the coiled initial part of the phragmocone. Throughout their visible length each ridge is separated from the anterior true callus by a narrow deep fissure.

Longitudinal depressions flank the central elevated zone of the ventral depressed area. Both are deepest and have a rather pitlike appearance at their apical ends just adorally of the branching point of the central elevated zone. Farther adorally the depressions rapidly become shallow and apparently disappear completely at the broken alveolar end of the lectotype (Pl. 3, fig. 2A,C). They are flanked by low, rounded, longitudinal ridges which branch off from apical ends of the oblique ridges which comprise the forked part of the central elevated zone. The ridges extend adorally between the longitudinal depressions and inner sides of ventrolateral flanges. They are indistinctly delimited from the adjoining longitudinal depressions but are well separated from adjacent surfaces of the ventrolateral flanges by narrow deep fissures underlain by sharp division planes which penetrate to the ventral side of the dorsal shield where they end abruptly (Pl. 2, fig. 3I, 4I; Fig 5). As seen in cross section at the oral end of the lectotype (Pl. 2, fig. 3I), the deep fissures are directed obliquely ventrolaterally. In ventral aspect they are continuous with the deep furrows which separate the anterior true callus harboring the coiled apicalmost part of the phragmocone from the apical branches of the central elevated zone (Pl. 3, fig. 2A,C).

Between the abrupt inner ends (i.e., bottoms) of the mentioned sharp division planes and the conotheca, the covering layer of the ventral depressed surface can be seen to extend without interruption around the phragmocone and to merge into the central part of the dorsal shield (Fig. 5). These structural relationships indicate that the covering layer is the oldest element of the sheath. The central part of the shield must have developed next as a dorsal broadly arched outgrowth of the sheath. The flanges, as such, must have appeared at somewhat later growth stages. As soon as they began to acquire the form of ventrolaterally directed, subtriangular outgrowths of the dorsal shield, however, the flanges grew independently and much faster than either the free part of the covering layer on the ventral depressed area or the dorsal shield proper. This is attested by the relatively much greater thickness of the flanges, by appearance of the above-mentioned abrupt boundaries between them and the free part of the covering layer from this moment on, and by the high arched to subtriangular shape of the growth lines of the flanges clearly visible in their cross sections in the oral end of the lectotype and larger topotype (Pl. 2, fig. 3I, 4I; Fig. 5).

Structural relationships observed in the oral cross sections of the lectotype and larger topotype are believed to be equally characteristic of the more adapical parts of the ventral depressed area. These parts of the covering sheath layer are completely separated by deep furrows and fissures from the ventrolateral flanges and the anterior true callus of the depression. Accordingly, these parts of the covering layer appear to have been also continuous with the dorsal shield only during early growth stages of the sheath. Later on they began to grow independently from its flanges, and these structural relationships were maintained throughout the remainder of the *Amerirostra americana* ontogeny.

As seen in the broken oral ends of the lectotype and larger topotype, the posterior part of the dorsal shield is built of dense, apparently well-calcified, distinctly and finely concentrically layered material. This material appears to be built largely of ill-defined fine calcareous prisms oriented normally to the outer surfaces of the shield and flanges. Irregularly and coarsely granulated sections occur locally but no cavernous and spongy structure or oolitelike well-calcified bodies are visible in these cross sections. Both types of structure are clearly observable (Pl. 3, fig. 2B),

however, in marginal parts of the flanges of the same specimens closer to their apical ends.

The larger apical callus of *Amerirostra americana* is superficially similar to the only mid-ventral true callus of *Spirulirostra* in being situated at the apical end of the depressed ventral area of its sheath. Unlike the latter, however, it is situated well adapically of the apicalmost part of the phragmocone, which in *A. americana* is enclosed in the second, more anteriorly situated true callus in the middle part of the depressed ventral area of its sheath. This anterior true callus thus is truly equivalent to the only mid-ventral callus of the *Spirulirostra* sheath.

The dorsal side of the sheath remains narrowly rounded from the apical end of the spike to the point slightly above the level of the anterior true callus when seen in dorsoventral aspect (Pl. 2, fig. 3C,G, 4C,G). Throughout this interval the dorsal side of the sheath is directed obliquely dorsally in relation to the shell's axis when viewed laterally (Pl. 2, fig. 3B,E-F, 4B,E-F). Above the level where the dorsolaterally converging, slightly convex to essentially flat flanks of the spike merge into the similarly oriented gently concave flanks of the sheath proper, the narrowly rounded dorsal side becomes more and more markedly delimited from the latter.

When viewed in lateral aspect (Pl. 2, fig. 3B,E-F, 4B,E-F), the direction of the dorsal side of the shield becomes more or less abruptly subparallel to the shell's longitudinal axis adorally of the level of the anterior true callus. At the same time the dorsal side of the sheath (i.e., when viewed in dorsoventral aspect, Pl. 2, fig. 3C,G, 4C,G) begins to flatten and to widen rapidly. This results in the appearance of an adorally divergent, almost flat dorsal shield extending to the broken oral ends of all three specimens studied. The shield is limited by straight, gradually adorally divergent rounded shoulders from the gently concave, outwardly sloping sides of the sheath. The shield is only slightly convex, except near the shoulders where the convexity increases rapidly adlaterally until the surface bends over in a narrow arch and merges into the flanks (Pl. 2, fig. 3I, 4I; Fig. 5). In the lectotype (Pl. 2, fig. 3C) the shoulders become gradually narrower and more abrupt adorally until they become separated from the gently concave flanks of the sheath by ill-defined, shallow but broad, longitudinal furrows near the broken oral end of this specimen (Pl. 2, fig. 3I; Fig. 5). The furrows rapidly become shallower and disappear adapically. Neither of the two topotypes studied exhibits these furrows, probably because they are less complete in their oral parts. It is believed that these furrows sharpen and deepen adorally and merge into those limiting the apical end of the buttress on the oral outgrowth of the shield.

When viewed in cross section (Pl. 2, fig. 3I; Fig. 5), the broken oral end of the lectotype exhibits the dorsal shield which has essentially the same proportions, shape, and size as the apical broken end of the only known example of the oral outgrowth of this shield (Pl. 2, fig. 5C). This clearly indicates that only a relatively insignificant section of the dorsal shield is missing between the broken ends of the two specimens.

When viewed dorsally, the preserved fragments of the posterior part of dorsal shield (Pl. 2, fig. 3C,G, 4C,G) have a narrowly triangular shape with the apex of the triangle situated adapically. If considered together with the only known specimen of its oral outgrowth, however, fragments suggest a narrowly featherlike shape of the complete dorsal shield, with its oral end obtusely spatulate and its apical end narrowly triangular. The shield is reconstructed accordingly (Fig. 3).

A long and broad, spatulate outgrowth projects adorally from the dorsal shield proper. This outgrowth was referred to as the proostracum by Berry (1922, p. 328), even though he clearly recognized that it is an adoral projection of the dorsal shield of the sheath rather than that of the conotheca. I have pointed out previously (Jeletzky, 1966, p. 67-68) that such usage is incorrect.

The only known example of adoral outgrowth of the dorsal shield lacks the section adjoining the oral end of the dorsal shield proper. However, not more than 8 to 10 mm. of the outgrowth are believed to be missing between its broken apical end (Pl. 2, fig. 5) and the broken oral end of the dorsal shield in the lectotype of *Amerirostra americana* (Pl. 2, fig. 3). If so, this adoral outgrowth of the shield of *A. americana* would be some 24 to 26 mm. long and thus about as long as the complementary fragmentary lectotype of the species, which is about 25 mm. long (compare Fig. 3).

The only known example of adoral outgrowth is almost complete at its oral end. In dorsoventral aspect (Pl. 2, fig. 5A,B) it widens gradually and evenly through about two-thirds of its length adorally from its broken apical end. Farther adorally the outgrowth contracts at a considerably greater and gradually increasing rate which yields the broadly linguliform shape of its oral third (Pl. 2, fig. 5A,B). The margins of the outgrowth are more or less convex throughout in dorsoventral aspect.

In cross section the dorsal side of the adoral outgrowth is only slightly convex within the thin (and gradually adapically thickening) adoral two-thirds. In the apical third of the rapidly adapically thickening outgrowth its dorsal surface is slightly convex within its median two-thirds but becomes increasingly convex closer to the margins until the surface bends over and becomes ventrolaterally oriented near the edges (Pl. 2, fig. 5C). This results in an asymmetrical positioning of the thickened and blunted edges of the outgrowth near its apical end. The edges become gradually thinner and sharper adorally within the apical third of the outgrowth as it gradually thins out in this direction. Thereafter the edges become symmetrical (in cross section), thin, and sharp within the oral two-thirds of the outgrowth.

The ventral side of the outgrowth exhibits two more or less flat marginal zones, each occupying about one-fourth of its total width (Pl. 2, fig. 5A). The central one-half to two-fifths of the ventral side is occupied by a more or less parallel-sided, buttresslike elevation referred to as a "broad central keel" by Berry (1922, p. 329). The buttress begins as a slight but sharply delimited elevation at the posterior end of the outgrowth and gradually rises higher above its general level adorally. Finally, it protrudes ventrally for a distance about twice the corresponding thickness of the outgrowth shortly before the oral end of the outgrowth (Pl. 2, fig. 5D-E). The top and flanks of the buttress are broken off very near the anterior margin of the outgrowth. Its basal part, however, extends entirely to its anterior margin. It is uncertain whether the buttress originally ended at this margin or continued for some distance adorally of it. The former alternative is favored for reasons given below (Fig. 3).

The cross section of the broken oral end of the buttress consists of an apparently well-calcified, thin (0.3-0.4 mm.), smooth to finely granular, dense covering layer which encloses an approximately rectangular space filled out by spongy and cavernous material. The protruding, apparently better-calcified structures of this inner space include some oolitelike, concentrically layered or irregularly shaped bodies separated by similar to vermiform cavities which originally appear to have been filled either by more poorly calcified or organic matter. However, several thin, ribbonlike, longitudinally layered bodies extend in a dorsoventral direction across this space; they may represent the oral cross sections of laminae extending longitudinally within the buttress. The covering well-calcified layer appears to be separated sharply from the enclosed spongy and cavernous mass in places. Elsewhere, however, it seems to grade into it. Addorsally the enclosed mass appears to merge imperceptibly into the body of the outgrowth proper, built of spongy, cavernous matter rich in oolitelike, rounded to budlike, better-calcified bodies. These bodies are well exposed on both surfaces of the outgrowth wherever its semismooth covering layer is damaged or abraded (Pl. 2, fig. 5A,B).

The cross section of the broken apical end (Pl. 2, fig. 5C) of the buttress consists entirely of the coarsely and irregularly granular, locally spongy and cavernous material with only a few oolitelike rounded bodies visible here and there. Unlike the cross section of the broken oral end of the lectotype, this section exhibits no distinct layering.

As the buttress becomes more elevated adorally it becomes narrower. However, its sides, which are deeply excavated near the apical end, gradually become less concave in this direction. Consequently, the buttress acquires a somewhat I-like cross section within the oral half of the outgrowth. The actually slight adoral narrowing of the buttress is made to appear stronger than it is by the circumstance that, as already mentioned, the outgrowth itself gradually widens in this direction over its apical two-thirds. The width of the buttress comprises about one-half of the outgrowth at its apical end and only about 0.4 of the same 11 mm. farther adorally where the outgrowth reaches its maximum width. The buttress is sharply set off from adjacent flat zones of the outgrowth by sharp but narrow longitudinal furrows which persist all along the ventral surface of its preserved part (Pl.2, fig. 5A,D). The concave right side of the buttress (Pl. 2, fig. 5E) is much weathered, so that most of its surface ex-

poses the spongy and cavernous material of its inner space. The left side, however, is mostly covered by a well-preserved, denser covering layer. The upper half of this side appears to be smooth throughout, whereas its lower half (adjoining the left flat zone) is covered by fine, sharp, more or less evenly spaced, almost longitudinal furrows. These furrows appear to subdivide adorally and to increase in number as the left side of the buttress gradually widens in this direction. Seven of them (in addition to the much stronger marginal furrow) were counted near the oral end of the buttress. At a distance of 9 mm. farther adapically they all disappear at the place where the left side is much damaged and the covering layer completely destroyed.

The ventral surface of the buttress is regularly concave throughout its preserved length (Pl. 2, fig. 5A,C). This regular concavity appears to represent a segment of the regularly conical cavity covered by a thin sheath layer. It presumably contained the adoral extension of the phragmocone. The inferred cavity and sheath cover originally must have represented direct continuations of the previously described cavity of the apical part of the phragmocone and its sheath cover. Such interpretation finds support in the circumstance that underlying layers of the ventral side of the buttress extend into a marked longitudinal ridge (Pl. 2, fig. 5A,D-E) on each side of the regularly concave depression concerned. Each of the ridges, which separate the ventral surface of the buttress from its concave sides, protrudes dorsoventrally from a broad base, thinning out rapidly in this direction, and becoming transformed into what appears to be the base of a thin, regularly curved wall (Pl. 2, fig. 5A,C). The continuations of the two walls are completely broken off, as indicated by the irregularly ragged fractures all along both rims of the ventral surface of the buttress (Pl. 2, fig. 5A,C-E). The breaks expose the previously described spongy and cavernous material of the inner space of the buttress. At these breaks each of the inferred, regularly curved walls is about 0.5 to 0.6 mm. thick. It is believed that the thin walls originally turned gradually toward each other in an arch and joined, forming a complete thin cone of sheath which contained the oral continuation of the phragmocone. Because of their thinness, both the sheath cone and the enclosed phragmocone were destroyed during burial, except for the dorsal wall of the sheath forming part of the buttress.

The concave ventral side of the buttress is strongly worn throughout so that its inner spongy and cavernous material is visible in many places through the denser outer layer (Pl. 2, fig. 5A). No traces of conotheca or septa are visible anywhere on its surface.

Internal Structure of Sheath.—As previously noted, the surface of the *Amerirostra americana* sheath is commonly covered by fine to medium-sized, subtransversely elongated to irregularly rounded, closely spaced tubercles separated from each other by irregularly shaped to vermiform, narrow grooves (Pl. 2, fig. 3-5; Pl. 3, fig. 2A-C). The pattern of tubercles and grooves was believed to reflect that of the inner surface of the enveloping mantle (Berry, 1922, p. 328). This structure often occurs, however, underneath the denser, more or less regularly concentrically laminated surface layer of the sheath (e.g., in cross sections of fragmentary flanges, of the dorsal shield or its oral outgrowth, and especially in the subordinated structural elements of the covering sheath layer of the ventral depressed area). The laminated surface layer of the sheath commonly is more or less glazed in appearance and appears to be much more strongly and evenly calcified than the internal sheath layers. These relationships alone indicate that the sheath structure is less directly connected with shape of the inner surface of the mantle than believed by Berry (1922). Furthermore, whenever seen inside sheath, the "tubercles" are partly or completely enclosed by a homogeneous to irregularly granular, apparently only imperfectly calcified or largely organic (conchiolinic?) matrix. Numerous irregularly shaped pits and vermiform cavities, presumably filled originally by this matrix, are interspersed with the areas of the latter. The available cross sections of the sheath reveal, finally, that what appear to be tubercles or irregularly shaped small mounds on the surface of the sheath are actually more or less regularly rounded to budlike, in places more or less distinctly concentrically layered (e.g., in the larger topotype; Pl. 2, fig. 4A,B), essentially oolitelike bodies, many of which are surrounded completely by the described, apparently imperfectly calcified matrix. Elsewhere, the bodies are almost entirely surrounded by cavities, which presumably originally were filled by the same imperfectly calcified

or largely organic (conchiolinic?) matter. In yet other instances the "tubercles" seem to merge imperceptibly into the underlying, regularly radially prismatic and concentrically layered inner sheath layers.

The predominantly spheroidal shape and concentrically layered internal structure of the well-calcified "tubercles" is particularly well exposed on the somewhat abraded ventral parts of the postalveolar sections of sheath's surface of the larger topotype of *Amerirostra americana* (Pl. 2, fig. 4A,B), on the surface of the only known specimen of adoral outgrowth of the dorsal shield (Pl. 2, fig. 5B), and in the various sculptural elements of the covering sheath layer of the ventral depressed surface of the lectotype (Pl. 3, fig. 3A,C). In these circumstances it seems probable that the deposition of each of the spheroidal, well-calcified bodies of the *A. americana* sheath (and also of the similar spheroidal bodies of other sepiids; see description of *Belemnosella americana*) began and proceeded independently.

All apparently were precipitated by individual, closely to sparsely spaced crystallization centers occurring on the inner surface of the enveloping mantle. These centers presumably became wider and wider for some time during the interval of deposition (i.e., until maximum diameters of the spheroidal bodies were reached), then gradually narrowed down again, finally disappearing. Only imperfectly calcified to largely organic (conchiolinic?) sheath matter apparently was deposited simultaneously between the spheroidal bodies by intervening parts of the mantle. The ratio of both types of precipitates must have fluctuated strongly but regularly during the interval of deposition of each layer of spheroidal bodies. Precipitation of the strongly calcified sheath matter of these bodies must have reached its acme in the middle of the time interval. Subsequently it gradually declined to nothing when precipitation of the spheroidal bodies of any individual sheath layer was completed. The acme of deposition of the imperfectly calcified to largely organic (conchiolinic?) intervening matrix, conversely, must have been at its peak at the beginning and end of the deposition interval of each sheath layer concerned.

The process apparently was repeated several times whenever several layers of the spheroidal, oolitelike, strongly calcified bodies occur superimposed on each other inside the sheath. The apparently localized presence of the spheroidal bodies is remarkable. Elsewhere, the sheath appears to be built either of the more or less granular, commonly porous material or of the ill-defined to more or less regular concentrical calcareous laminae transversed by the radial calcareous prisms. It seems that the mixed calcareous-organic texture of the sheath, characterized by predominance of well-calcified spheroidal bodies, was restricted to its unusually fast-growing parts (Jeletzky, 1966, p. 64). Other, more slowly growing sheath parts (e.g., the outermost, glazed layer of the sheath and the sheath layer of the spine proper) apparently possessed an essentially Belemnitida-like structure characterized by deposition of the more or less regular and dense concentric lamellae of strongly calcified (aragonitic?) matter. These lamellae only posthumously were pierced by the fine, radially oriented crystalline prisms of calcium carbonate similar to those of the Belemnitida. It seems likely that the supply of calcium carbonate failed to keep pace with the increased demand for it during the time of exceptionally fast growth of the sheath. This was remedied by precipitation of the imperfectly calcified or largely organic matter in intervening spaces between well-calcified elements of the sheath.

Phragmocone.—Judging by the lectotype of *Amerirostra americana* (Pl. 2, fig. 3A,I; Pl. 3, fig. 2A,C; Fig. 3), the early camerae of its phragmocone are somewhat loosely coiled endogastrically. They form a complete whorl with the relatively large, equidimensionally bulbous protoconch resting directly upon the ventral surface of the younger, cyrtochoanitic part of the phragmocone. The initial coil is gyroconic rather than truly evolute. The coiled camerae do not touch at any point so far as one can see, and the diameter of the umbilical perforation approaches that of the coiled part of the whorl. The perforation is filled by sheath matter consisting of two morphologically distinct, sharply delimited layers. The thinner (0.25 mm.) outer layer lining the conotheca is dense, and consists of fine transversely oriented calcitic prisms. It surrounds the tubelike remainder of the umbilical perforation which is filled by an agglomeration of fine (0.1-0.05 mm.), calcareous, oolitelike bodies enclosed in apparently structureless, more poorly calcified matter. This material appears to be continuous on both sides

of the umbilical perforation with the similarly structured matter of the central elevated zone of the depressed area and its flanking ridges (see section on the ventral depressed area). It is estimated that the coiled part of the phragmocone consists of five or six camerae including the protoconch.

The preserved younger parts of the phragmocone are markedly cyrtoconic. Some 15 to 16 camerae are believed to be preserved in the lectotype specimen. Only a segment comprising seven camerae of the early cyrtoconic stage is preserved in the larger topotype (Pl. 2, fig. 4A,D). These are believed to represent the 9th to 15th camerae. For reasons fully discussed in the previous section it is believed that the phragmocone originally ended somewhat before the oral margin of the adoral outgrowth of the dorsal shield (Fig. 3).

The phragmocone is somewhat depressed in cross section, its lateral diameter exceeding the dorsoventral diameter of the lectotype (Pl. 2, fig. 3I). The diameters cannot be measured exactly in the lectotype, however, because of its rather unevenly broken oral end. In the larger topotype (Pl. 2, fig. 4I) the lateral diameter is 3.2 mm., as compared with 3.0 mm. for the dorsoventral diameter at the same level. This results in a depression ratio of about 0.94. The cross section of the phragmocone is a somewhat rounded trapezoidal shape, with the largest lateral diameter situated somewhat closer to its flattened ventral side (Pl. 2, fig. 3I, 4I).

The apical angle of the cyrtoconic part of the phragmocone appears to be about 10 to 12 degrees in lateral aspect and about 15 degrees in dorsoventral aspect (Pl. 3, fig. 1A,C). It was not possible to measure it more exactly in the only specimen available (the larger topotype) because of the marked endogastric curvature of all preserved parts of the phragmocone.

In the larger topotype (Pl. 3, fig. 1A-D) the height of camerae appears to fluctuate between 0.36 and 0.40 of their dorsoventral diameter (e.g., 0.9 and 2.5 mm. in the third camera from the top and 1.1 and 2.6 mm. in the second camera from the top). It is not possible to measure it even approximately in other specimens.

The conotheca is very thin (about 0.2 to 0.3 mm. in the lectotype and larger topotype), pure white, apparently smooth, and well calcified. The microscopic structure of the conotheca is unknown as the only thin section made was accidentally destroyed in the latest stages of grinding. No proostracal pattern was observed on the inner surface of the conotheca in the only specimen (larger topotype; Pl. 3, fig. 1C,D) where the latter was seen. When seen with a binocular microscope at magnifications ranging from ×12 to ×50 (Pl. 3, fig. 1A-D) the inner surface of the conotheca appears to be smooth on the venter and adjoining parts of the flanks. Elsewhere it bears closely, evenly spaced, very fine, transverse furrows and ridges apparently representing its growth lines. The outer surface of the conotheca was only seen in small fragments on the dorsum and flanks of the same specimen where it appears to be smooth in places but carries the transverse furrows and ridges elsewhere. Although inconclusive, the above observations do not seem to favor the presence of a true proostracum in *Amerirostra americana*. The inner and outer surfaces of the conotheca distinctly contract over the septa and expand in low arches between them, just as happens with the conotheca of *Spirula* and *Groenlandibelus* (Jeletzky, 1966, p. 98).

The hard marginal (ventral) siphuncle was only seen in the larger topotype (Pl. 3, fig. 1A). It is so poorly preserved that neither its dimensions nor shape were observable. At any rate it appears to be wider than the siphuncle of the Belemnitida and expands markedly between the septa so that its ventral wall touches the inner surface of the conotheca throughout most of this interval. The siphuncle was probably markedly beadlike, at least in ventral aspect.

The suture only feebly slopes toward the venter (Fig. 4). It exhibits a well-defined but narrow and shallow, triangular ventral lobe. Therefrom, the suture rises gradually and more or less evenly on the greatest part of the ventral face, all of the ventrolateral face, and all of the lateral face of the phragmocone. Then it forms a shallow, very broadly arched, wide saddle occupying its entire dorsolateral quadrant. An equally shallow, very broadly concave, wide lobe follows, occupying about three-quarters of the dorsal side of the phragmocone (Pl. 3, fig. 1A-D; Fig. 4).

Slightly elevated, well-defined septal lines (Flower & Gordon, 1959, p. 813-814) occur about one-quarter of the height of each camera adorally of the suture lines. The septal lines of the larger topotype generally follow the same course as the

suture lines, except that they either do not seem to form any ventral lobes at all (oralmost suture) or form only faint ventral lobes (Pl. 3, fig. 1A-D; Fig. 4). Furthermore, details in the course of the septal lines of the topotype across the dorsum are partly obscured by their poor preservation. It is inferred, however, that they follow that of the adjacent suture lines throughout this interval. No interruption of the septal lines occurs immediately adorally of the ventral lobes of the suture lines.

The slightly elevated, flat-topped zones between the suture lines and the septal lines are underlain by very thin (0.1-0.2 mm.) more or less parallel-sided to slightly adorally thinning laminae of white to yellow, fine-grained calcium carbonate overlying directly the sandstone-filled camerae. These laminae end abruptly oralward, the cause of the septal lines. Adapically they bend over and disappear inside the phragmocone at the suture lines. This indicates that they are short but well-delimited mural parts of the septa. Therefore, the septal lines of *Amerirostra americana* appear to be expressions of the oral margins of adorally directed, short flanges of the mural parts of the septa. FLOWER & GORDON's (1959, p. 813) suggestion that similar septal lines of some Palaeozoic Coleoidea reflect the oral margins of small, essentially abortive cameral deposits does not seem to be applicable to this sepiid form at least. It was, unfortunately, impossible to confirm this observation in transverse and longitudinal thin sections. Judging by the circumstance that the mural parts of the *A. americana* septa were locally observed to overlie directly the sandstone-filled camerae, this species did not possess any cameral deposits.

The above-described appearance of the suture and septal lines of the larger topotype is somewhat less distinctly visible to the naked eye and magnifying lens (up to ×10) on the inner surface of the lectotype of *Amerirostra americana,* except that in this specimen not only the suture line but also the septal line appears to form a shallow and narrow, triangular ventral lobe in the two adoral septa preserved. These septa of the lectotype also confirm the suggested interpretation of the nature of septal lines. The visible fragments of the free parts of these septa bend over adorally at the suture lines and merge into the somewhat elevated calcareous lamellae underlying the zones between these latter and the septal lines all around the phragmocone. These lamellae end abruptly at the septal lines.

In the lectotype the septal lines concerned are obviously following the outline of suture lines all around the dorsum and do not approach them or merge with them anywhere in this interval. The presence of a broad and shallow dorsal lobe of the suture lines is not apparent in the suture lines of the lectotype. This could be due to an optical illusion, however.

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